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THE TWELVE-WHEEL LOCOMOTIVE of the Adirondack & St. Lawrence Ry., illustrated in our issue of June 18, has a heating surface of 2,331 sq. ft. (2,106 for the exterior surface of tubes and 225 ft. for the firebox). The ratio of heating surface to grate area is 76.67. The engine will work on a maximum grade of 2.3%.

A RAILWAY COMMISSION FOR LOUISIANA is proposed to be created by a bill which is to be introduced in the state legislature, the main idea being the regulation of rates.

COMPRESSED AIR MOTOR CARS of the Hardie system are to be tried on some of the branch lines of the Third Ave. Ry., in New York.

A STREET RAILWAY TRANSFER STATION is proposed at Providence, R. I., for the convenience of passengers using the various lines of the Union R. R. Co. There will be a waiting-room 104 x 42 ft., with a track along each side, and the cars of all routes will meet here, so that passengers will have free transfer from one line to another.

ELECTRIC TRACTION has now superseded steam on the Lake St. elevated railway, at Chicago. The feed rail or conductor is charged from three power stations, each of which supplies current for a certain distance, but in case of a failure, any one station can supply the current for the whole road. There will be 20 motor cars, all fitted with Westinghouse brake pumps for the train brakes. The South Side elevated railway will also adopt electric traction.

THE EAST RIVER BRIDGE TERMINALS, as decided upon by the commission, will occupy the two blocks bounded by Norfolk, Clinton, Broome, and Delancey Sts., in New York, the bridge approach being parallel with the latter street. In Brooklyn the approach will be parallel with South 6th St. to Berry St., then crossing South 5th St. diagonally to Bedford Ave. and Driggs Ave., with an approach from East Broadway to South 4th St.

THE FERRY STREET SUSPENSION BRIDGE over the Chenango River, at Binghamton, N. Y., has been examined by Mr. Charles F. Stowell, M. Am. Soc. C. E., Consulting Engineer to the Railroad Commissioners of New York, and declared to be unsafe, and Mr. S. E. Monroe, City Engineer, has reported to the city council that the bridge is not in condition to carry the traffic daily imposed upon it. In 1890 Mr. Stowell examined the bridge, a street railway company having applied for permission to run electric cars over it, and he stated that if the floor system were strengthened, light cars might be run. The strengthening was not carried out to the extent recommended, and very much heavier cars have been run over than the company said it would operate, so that the stiffening trusses are now badly out of shape. The cable wires also are badly rusted at the anchorages. The bridge was never designed for such traffic as it now carries, and Mr. Stowell has recommended that it should be closed to car and vehicle traffic. The bridge has a span of 362 ft. c. to c. of towers, and each of the main cables is composed of seven 1⅛-in. wire ropes, having a dip or sag of 30 ft. There are a 16-ft. roadway and two 6 ft. sidewalks, a wooden stiffening truss resting on the ends of the floor beams, outside the sidewalks. The floor is suspended by vertical hangers (of 1-in. rods or ⅞-in. wire ropes), 5 ft. c. to c., dividing the clear span into 70 panels of 5 ft. each. The main cables are supplemented by eight back stays from each tower to alternate hangers from the third to the seventeenth hanger.

A BRIDGE OVER THE MISSOURI RIVER at Yankton, S. Dak., is to be built by the Yankton & Northern Ry., which will be a connection of the Great Northern Ry. The bridge will be for railway traffic only and will cost about $500,000.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a rear collision on the Central Vermont R. R., near Montpelier, Vt., June 22. A stock train was preparing to take the sidetrack when a coupling broke, and before the train could be coupled up and got out of the way it was struck by a southbound express train. The caboose was smashed and two men in it were killed. The engine, with the express and mail cars, went over the bank, and the fireman was badly injured.——There was a narrow escape from an accident, on June 20, at the bridge carrying the Chicago, Burlington & Quincy R. R. over the Mississippi River, at Burlington, Ia. An express train was approaching the bridge when the draw was open, but the engineman was dead in the cab, and the train would not have been stopped if the fireman had not seen the signals.

A CAR FELL INTO THE STREET from the Lake St. electric elevated railway, in Chicago, on June 20, seriously injuring three persons. The train was run onto a dead-end siding by a misplaced switch, and carried away the bumpers, the combination motor and passenger car going over the end, while the other cars remained on the track.

THE LOSS OF THE STEAMER "Drummond Castle," of the Castle Line, on June 16, resulted in the loss of 244 lives, only three persons having been saved. The steamer was bound from Cape Town to Plymouth, and during a stormy night it struck a sunken rock off Cape Ushant, on the French coast, and sank in a few minutes.

A BOILER EXPLOSION ON A STEAMER occurred June 18, at Utica, N. Y., killing ten persons and injuring six others. The vessel was the pleasure steamer "Titus Sheard," which was carrying passengers from Little Falls to Taylor Driving Park, and the accident is said to have occurred just as the engineer shut off steam at the Taylor Park landing.

THE BURSTING OF TWO BOILER TUBES on the Mallory Line steamer "City of San Antonio," June 22, while the vessel was off Sandy Hook, necessitated the return of the ship to New York. One of the firemen was seriously scalded.

THE COLLAPSE OF A BUILDING at San Francisco, Cal., on June 22, caused the deaths of five persons and the injury of nearly 20 others. It was a three-story frame building, and was to be strengthened by new underpinning, but the temporary supports put in during the carrying on of the work were not strong enough to carry the load.——A corner of the Sisson block, at Hartford, Conn., fell into Park River, June 16. The building is at the side of the river, with its foundations resting on a rock ledge, and severe vibrations have been felt during recent blasting operations for sewers in neighboring streets.

THE BURSTING OF THE DAM of a reservoir at the head of Goodrich Creek, 12 miles from Baker City, Ore., on June 15, caused extensive damage along the valleys of Goodrich Creek, Pine Creek and Powder River. One farmhouse was carried away and an entire family of seven persons drowned. The dam wes repaired last year, and it is said that the repaired portion gave way.——The dam of the Alycon Lake, in Gloucester county, N. J., gave way June 18, and the flood caused considerable damage. The lake was an artificial one, for the use of pleasure parties at Alycon Park.——The government dam on Pine River, Minnesota, broke June 19, a section 200 ft. long being carried away. The gates were promptly opened to lower the water in the reservoir.

THE SEPARATION OF THE SEWAGE AND SURFACE water of Worcester, Mass., is recommended by Mr. F. A. McClure, City Engineer. The city now has about 90 miles of sewers on the combined plan and only seven miles of separate sewers, besides which it is to be noted that through the rise of Mill Brook, as an outlet sewer, the amount of surface water is still further increased. The estimated cost of the work recommended by Mr. McClure is $892,739. The work of separation has long been contemplated and is rendered necessary by the fact that the city attempts to purify the sewage before discharging it into the Blackstone River. In this connection it may be noted that Mr. Harrison P. Eddy, Superintendent of Sewers, has recommended that $100,000 be appropriated for sludge pressing machinery and accessories. At present the sludge is turned into sludge beds to dry. The desired appropriation for sludge disposal is now before the city council.

THE NEW ORLEANS DRAINAGE PLANS outlined in our issue of Nov. 8, 1894, and May 30, 1895, have been endorsed by the city council. A bill is before the state legislature authorizing the issuance of $5,000,000 of 5% 40-year bonds for the work.

A CONTRACT FOR ELECTRIC MOTORS for driving sewage pumps is reported as awarded at Jacksonville, Fla., to the Morris Machine Works, of Baldwinsville, N. Y. The motors, of which there will be two, will be of 15 HP. each, and will each drive a 6-in. centrifugal pump. The contract price for the motors is given as $2,250. An 8-in. centrifugal pump will be driven by a steam engine. These pumps will be placed at three different points in the city to lift sewage to the main sewers.

STEAMERS FOR JAPAN may be built in this country for a Japanese company with $5,000,000 capital, which intends to run a line of steamers from Japanese ports to Portland, Ore., and has a subsidy for vessels of over 6,000 tons. Mr. S. Asam, of Tokio, is now in this country to enquire as to the cost of building steamers of 6,000 to 9,000 tons for this service.

GRAIN STEAMERS with heavy cargoes are being sent from Brooklyn, N. Y., to South Africa, and as the grain is loaded in 200-lb. double sacks, instead of in bulk, it is presumed that it is to be unloaded at some small ports which are not equipped with grain handling plant. The largest vessel yet sent is the "American," of the West India & Pacific Steamship Co. It is 498 ft. long over all, 475 ft. long between perpendiculars, 56 ft. beam and 37 ft. depth of stowage space, and a capacity for 11,190 tons of freight. There are nine cargo hatches, each fitted with steam hoisting apparatus. The twin screws are driven by triple-expansion engines with cylinders 19, 31 and 52 ins. diameter and 48 ins. stroke. The speed is about 12 miles per hour, and it is expected to make the trip to Cape Town, 6,820 miles, in 26 days, averaging 10 miles per hour. The freight on this first trip includes 3,700 tons of white corn in bulk, 300 tons of oats in bulk, 2,000 sacks of bran (for east coast ports), 15,000 cases of petroleum, steam engines, mining machinery, electric cars, etc.

A SHIP MODEL TESTING TANK, 300 ft. long, 40 ft. wide and 12 ft. deep, is to be built at the Washington navy yard for experiments as to the resistance of hulls of different shape, etc. Along each side will be a track on which a carriage, propelled by electrical motors, will travel at any desired speed. This carriage, or the model, if so desired, will bear the delicate mechanism to record the power needed to pull the model through the water, mark distance travelled and the time consumed, and register the presence of disturbing drafts or currents. The models, which are to float beneath and be attached to the movable carriage, will vary in length from 10 to 30 ft., being made as large as possible that their performances may be on a corresponding scale and less likely to disguise small errors, multiplied correspondingly in the greater vessel. These models are of paraffin wax, because that substance does not change its weight by absorbing water, is easily cut and readily modified to suit alterations suggested by experiment, and the wax can be melted and used again for other trials.

CONVICT LABOR FOR ROADS is to be employed in Fayette county, Texas, and a contract has recently been entered into between the county commissioners and Homuth & Cornelson, who have established a permanent road plant in the county to build roads for five years. The cost of double teams and drivers to be as follows: First year, $3.50 per day per team and driver; second year, $3.50; third, year $3.30; fourth year, $3.30; fifth year, 3.25. The county is to be allowed $7.50 per month for each convict. The county is to furnish work for six months in each year for 20 teams, extra hand labor to be rated at $1.25 per day each. The contractors guarantee to build six miles of road each year. The board bill of the sheriff of Fayette county has, since the convicts were let out to hire, decreased $260 every three months. Good roads are now being built at 73 cts. per yd., which is one-third of the old contract price. The contractors make the convicts raise what they consume, so that they are made self-supporting and a benefit to the county.

BUILDING LEVEES BY HYDRAULIC DREDGING is being tried in the Louisiana delta about 60 miles below New Orleans, under the direction of Capt. Geo. McC. Derby. The hydraulic dredge "Ram" is being used to dredge material from the river bed and deposit it behind a temporary retaining wall of planks which is built up in terraces as the work progresses. In the early part of last year similar experiments were conducted for some ten days, and are described in the last report of Capt. Derby (Report of the Chief of Engineers, 1895, p. 3,922). The experiments this year have been chiefly devoted to endeavors to determine the best method of confining the excavated material at the sides, and the best success has been attained by the use of willows in connection with the plank barriers. The mixture pumped is so soft that it will run for nearly a quarter of a mile along the level before the sediment will settle. The experiments are of great importance as it is estimated that levees can be built in this way for half the cost of the ordinary method.

THE RAILWAY ICE BRIDGE OF 1852 ACROSS THE SUSQUEHANNA RIVER.

An interesting reminder of railway methods of more than 40 years ago is sent to us by Mr. Andrew Onderdonk, of St. James College, Md., and is here reproduced. The scene is located near the head of Chesapeake Bay at the Susquehanna River crossing of the old Philadelphia, Wilmington & Baltimore Ry., between the towns of Perryville and Havre de Grace, Md. No bridge over the river existed at that time, and all trains were ferried across on the transfer steamer "Maryland," now doing similar duty in the harbor of New York by connecting certain trains on the Pennsylvania and New York, Hartford & New Haven railway systems.

In severe winters the river was badly blocked with ice, and the transfer of trains was frequently interfered with. But the Susquehanna is not very deep at this point throughout its width, and the presence of Watson's Island above the crossing aids in jamming the ice until it sometimes packs solid from the riverbed upwards, the flow of water being confined to the two deeper channels beneath the ice. On several of these occasions ties and rails were laid directly upon the ice, and this track was connected with the railways by inclined planes operated by pulleys and strong cables, the motive power being supplied by the locomotives. In this manner passenger and freight cars were transferred across the 4,000 ft. or more of ice and sent on their way north or south. The lithograph here reproduced shows such a railway ice bridge as operated in 1852, from a sketch made by the once well-known artist, F. H. Schell. The smaller cuts are reproduced from views on the same lithographed sheet as that on which the general view of the bridge is shown.

The first bridge across the Susquehanna at this point was a wooden, arched Howe truss structure, opened to traffic by the Philadelphia, Wilmington & Baltimore R. R. Co. in 1867, and later replaced by an iron bridge. In 1885-86 the Baltimore & Ohio R. R. Co. built a bridge about 6,000 ft. long, crossing the island above the line of the older bridge, in connection with its Philadelphia and New York extension.

The village of Havre de Grace, on the south bank of the river, has had an interesting history. It was laid out in 1776, was burned by the British in 1812, and was once strongly urged as the seat of government of the United States. Plans were actually made with this end in view, and old maps still exist showing the site for the government buildings, public squares, monuments, etc. The present town is built upon this plan, a fact which explains the existence of streets 200 ft. and more wide in a town of about 3,000 inhabitants. As we remember it, this plan was made by the French engineer L'Enfant, who later laid out the city of Washington and originated its present excellent arrangement of streets.

THE RAILWAY ICE BRIDGE OF 1852 ACROSS THE SUSQUEHANNA RIVER AT HAVRE DE GRACE, MD. (Reproduced from an Old Lithograph.)

STANDARD TRACK OF AMERICAN RAILWAYS.

In the accompanying tables and notes we present very full particulars of the present standards of track construction as adopted by leading railway systems in all parts of the United States and in force at the present time. The records thus presented cover the entire wide range of the country, as will be seen by the accompanying sketch map, which shows only the railways from which returns have been received in connection with this article. Of course every road has in service a certain proportion of older and lighter track, but the standards adopted appear to be fairly satisfactory. We have, in our editorial column discussed some of the points brought up by this record, and, therefore, leave the matter without further comment in this place. We have to express our thanks to the several engineers who have replied to our requests for the information here compiled in tabular form.

Rails.

Atchison, Topeka & Santa Fe Ry.—The standards for new rails are the 65 and 75-lb. sections of the Am. Soc. C. E. pattern. The rails in use are from 52 to 75 lbs. per yd., but none lighter than 65 lbs. have been ordered since 1890.

Boston & Albany R. R.—The standard 95-lb. rail is gradually replacing the 72-lb. rails.

Burlington, Cedar Rapids & Northern Ry.—The rails in use vary from 50 to 80 lbs. per yd., but only 80-lb. rails have been bought for the last two years, so that this is the standard, though it may be a long time before all the track is laid with it.

Chicago & Alton R. R.—The standard rail, adopted in 1895, is the 80-lb. Am. Soc. C. E. section, but there are in the main track rails of 60, 70 and 80 lbs. per yd.

Chicago & West Michigan Ry. (and Detroit, Lansing & Northern R. R.—These are single track roads, with rails of 50, 52, 56, 57, 60 and 70 lbs. per yd., the 70-lb. rail of the Am. Soc. C. E. having now been adopted as the standard.

Chicago, Burlington & Quincy R. R.—Some branches have 65-lb. rails, but the standard is 75 lbs. per yd.

Chicago Great Western Ry.—The rails on the main (single) track are 60 lbs. per yd., section 6,001 of the Illinois Steel Co., but some bad kinks have been renewed with 75-lb. rails of the Am. Soc. C. E. section.

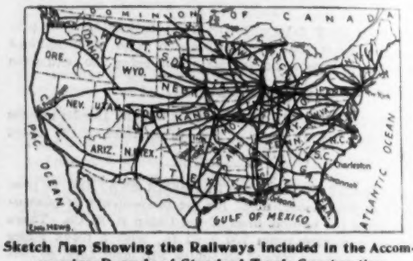
Chicago, Milwaukee & St. Paul Ry.—The standard for 1896 will probably be an 85 or 90-lb. rail for the principal lines. The present standards are 60, 65 and 75 lbs. per yd.

Cincinnati, New Orleans & Texas Pacific Ry.—The line is single track, with 207 miles of 60-lb. and 129 miles of 75-lb. rails, the latter being used in renewals. Side tracks have 53 to 60-lb. rails.

Denver & Rio Grande R. R.—The following is a statement of rails and joints in use:

	Rails.	Joints.	No. of bolts.	Size of bolts.	Length of bolts.	Spacing of bolts.
St. gage, main line..	85	Susp.	4	⅞	24	6, 6, 6
St. gage, main line..65,	75	3-Tie	6	⅞	40	7, 7, 6, 7, 7
St. gage, branches...	52	Susp.	4	⅞	24	6, 6, 6
Nar. gage system....	52	Susp.	4	⅞	24	6, 6, 6
Nar. gage system....	45	Susp.	4	⅞	22	5, 4½, 5
Nar. gage system....	40	Susp.	4	⅞	20	3½, 4½, 3½,
Nar. gage system....	35	Susp.	4	⅞	22	5, 5, 5

Louisville, New Albany & Chicago Ry.—The present standard rails are 75 lbs. per yd., of the Am. Soc. C. E. section, and are 33 ft. long. There are, of course, lighter rails in use, but none are now purchased.



Sketch Map Showing the Railways Included in the Accompanying Records of Standard Track Construction.

Minneapolis, St. Paul & Sault Ste Marie Ry.—The present standard is 70 lbs. per yd., the old standard was 60-lb.

New York Central R. R.—The rails used are as follows: 65 lbs. per yd. on minor branch lines and in yards; 67-lb., West Shore R. R. standard; 70-lb., Rome, Watertown & Ogdensburg R. R. standards; 75-lb., Mohawk & Malone R. R. (Adirondack R. R.) standard; 80-lb. and 100-lb., New York Central R. R. main line standard (100-lb. on line from New York to Albany only).

New York, New Haven & Hartford R. R.—The 100-lb. rails are 6 ins. high; 78, 74 and 70-lb. rails, 4 11-16 ins. high.

Pennsylvania R. R.—The main lines have 70, 85 and 100-lb. rails, and there are 60-lb rails in use in main running tracks on some of the branch roads.

Philadelphia & Reading R. R.—The standard is a 90-lb. rail between New York and Philadelphia, and 80 lbs. elsewhere.

Southern Ry.—An 80-lb. rail is used on the main line between Washington and Danville, and a 75-lb. rail on the other lines.

Spikes.

Duluth, South Shore & Atlantic Ry.—This road used Goldie spikes, 9-16×5½ ins.

New York Central R. R.—The standard is the Goldie steel spike, 9-16×9-16×5½ ins.; there are also a few lag screw and clip fastenings.

New York, New Haven & Hartford R. R.—The spikes are 9-16 in. square, 5½ ins. long under the head, 6 ins. long over all.

Rail Joints.

A., T. & S. F. Ry.—Previous to 1890 the standard was a supported joint with 23-in. angle bars and four bolts; from 1890 to 1894 the standard for new rails was a three-tie joint with sawed ties, 38-in. angle bars and six bolts. Since 1894 the standard has been the bridge joint of the Heath make, with 24-in. bars (22-in. bars are also in use), and there are four bolts. There are now

about 220 miles of track laid with this joint, and it is contemplated to lay 140 miles this year. It has not been in service long enough to allow of a definite opinion being given as to its merits.

Central of Georgia Ry.—Harvey grip-thread bolts are used, with Ideal recessed nuts.

Chicago & Alton R. R.—The 80-lb. rails have suspended joints with 26-in. angle bars and four pressed steel bolts $\frac{7}{8} \times 4\frac{1}{2}$ ins., spaced 6 ins. c. to c. The 70-lb. rails have three-tie joints with 40 and 42-in. (mostly 40-in.) angle bars and four steel bolts, $\frac{7}{8} \times 4\frac{1}{2}$ ins., spaced 9, 7 3-16 and 9 ins., c. to c. The 60-lb. rails have suspended joints with 26-in. angle bars, and four bolts.

Chicago & West Michigan Ry. (and Detroit, Lansing & Northern R. R.).—Supported joints with fish-plate splices were originally used, and then a suspended joint with angle bars was adopted. Within the past few years a three-tie joint with long angle bars has been adopted, but the engineer does not believe in the long angle bar, and would prefer either the Continuous bridge joint or the bridge joint adopted by the Chicago & Northwestern Ry. in May, 1889, which has a base plate and Samson angle bar. The suspended joint has 26-in angle bars with four bolts, $\frac{3}{4} \times 4$ ins., with nut-locks. The three-tie joint has 38-in. angle bars with six bolts of the same size. All the bolts are spaced uniformly, 6 ins. c. to c. The reason for this is that in case a section man finds a broken angle bar and has not a new one to put on immediately, he can use one of the pieces over the Churchill bridge joints, with four bolts through the rail and two under the rail.

Seaboard Air Line.—The Continuous joint, supported, is the standard.

Southern Pacific Ry. (Atlantic System).—The standard is a suspended joint with shoulder ties $8\frac{1}{2}$ ins. apart in the clear, and two tie-plates on each shoulder tie. The other ties are nearly 23 ins. c. to c. The bolts are $\frac{3}{4}$-in. diameter, 4 ins. long under the head, threaded for $1\frac{1}{2}$ ins., and having a $\frac{5}{8}$-in. neck, $\frac{3}{4} \times 11\text{-}16$ ins.; the nuts are $1\frac{5}{8}$ ins. square and $\frac{7}{8}$ in. thick. The splice bars have holes $\frac{7}{8} \times 1\frac{1}{8}$ ins., and the rail holes are 1 in. diameter.

Wabash R. R.—A three-tie joint, with 44-in. splice bars and six bolts has been used for several years, but is considered as expensive and scarcely satisfactory. Several different joints will probably be tried experimentally before any standard is adopted.

Ties.

A. T. & S. F. Ry.—The red spruce and white cedar ties are used only on branch lines. All mountain pine ties are treated by the Wellhouse (zinc-tannin) process. There are 18 ties per rail on main line and 16 per rail on branches.

B. & O. R. R.—The ties are of white, chestnut, burr or rock oak, 7 ins. thick, not less than 7 ins. wide, 8 ft. 6 ins. long, on lines east of the Ohio River, and 8 ft. long west of the Ohio River.

B., C. R. & N. Ry.—The ties are of white oak except on lines in Louisiana, where black and red cypress ties are used.

Minneapolis, St. Paul & Sault Ste. Marie Ry.—The ties are of oak, 6×8 ins.; costing 40 to 43 cts.; cedar, tamarack and hemlock, 7 or 8 ins. wide and 7 ins. thick; cedar ties cost 22 cts. each, and soft wood ties $17\frac{1}{2}$ cts. each. There are 17 or 18 ties per rail length, according to size.

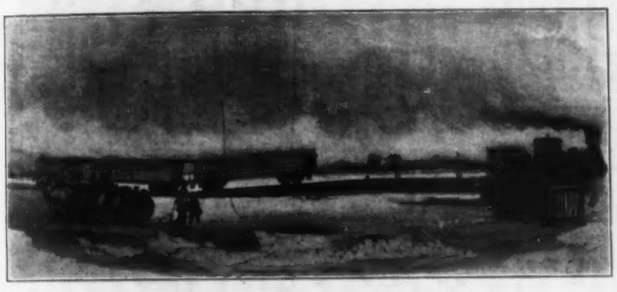
Missouri Pacific Ry.—The ties are of oak, 6×8 ins. 8 ft. long and cost $32\frac{5}{8}$ cts. each, on the Missouri Pacific Ry., and $25\frac{1}{2}$ cts. each, on the St. Louis, Iron Mountain & Southern Ry.

Nashville, Chattanooga & St. Louis Ry.—The ties are of white and post oak, with a minimum and average width of 8 and 10 ins., 7 ins. thick, 8 ft. 6 ins. long.

New York Central R. R.—Southern yellow pine is regarded as the standard, but oak and chestnut are used, and a few tamarack and cedar ties. There are also about 19,000 steel ties.

Norfolk & Western R. R.—The standard size is 8 ft. 6 ins. long, 7 ins. thick, with a hewed face of 7 ins. minimum width, the average width of face being 9 ins. First-class ties cost 28 to 38 cts., depending upon length of haul, the average being 33 cts. The engineer states that on account of the low price of ties no attempt is made to preserve them, but it may be doubted if this is a correct view of the case from an economical point of view.

Philadelphia & Reading R. R.—The ties are of white oak, hewed on two sides, 7×7 ins., 8 ft. 6 ins. long; first-class ties cost 60 cts. each.



Transferring Cars at the River Bank.

Transfer Steamer and Bridges at Havre de Grace.

joint until a new one can be supplied. These pieces can also be used in sidetracks instead of putting on whole angle bars.

Chicago Great Western Ry.—The 60-lb. rails have suspended joints with 22-in. angle bars and four bolts, $4\frac{1}{2}$ ins. c. to c., the bolts being $\frac{3}{4} \times 3\frac{1}{2}$ ins., with Verona nutlocks; the bars weigh 18 lbs. each. Some Heath bridge joints, 22 ins. long, are also used. The 75-lb. rails have suspended joints with 26-in. angle bars and four bolts, 6 ins. c. to c., the bolts being $\frac{7}{8} \times 4\frac{1}{2}$ ins., with Harvey grip thread.

Denver & Rio Grande.—(See Rails.)

Florida Central & Peninsular R. R.—Suspended and supported joints are in use, but the engineer prefers the latter.

Great Northern Ry.—The track bolts are $\frac{3}{4}$-in. diameter and $3\frac{5}{8}$ ins. long under the head.

Gulf, Colorado & Santa Fe Ry.—The Heath bridge joint, with 24-in. bars and four bolts is now used.

Kansas City, Fort Scott & Memphis R. R.—No standard has been adopted, but various kinds are in use, including suspended joints with 24-in. bars, and the Continuous bridge joint with 19-in. bars.

Minneapolis, St. Paul & Sault Ste. Marie Ry.—Suspended joints are used except on about 170 miles of track, where three-tie joints are used. The engineer was opposed to the use of the latter, with 40-in. angle bars, and it is not probable that any more will be used, as the persons who favored them are now ready to consider the shorter bars. The present track bolts are of steel, $\frac{3}{4}$-in. diameter, with rolled thread.

New York Central R. R.—The bolts are of cold-rolled steel, $\frac{3}{4}$-in. diameter, with Harvey grip-threads and Ideal recessed nuts.

Norfolk & Western R. R.—The standard for 85-lb. rails is a suspended joint, with six steel bolts, $\frac{3}{4}$-in. diameter, having the Harvey grip-thread and nut. There are on trial a large number of the

and cedar; the oak being used on all curves, and on the tangents of lines carrying the heavy traffic.

Chicago & West Michigan Ry. (and Detroit, Lansing & Northern R. R.).—The cost of ties, delivered on the right of way, is 30 to 40 cts. for oak, and 15 to 20 cts. for hemlock, cedar and tamarack. Preserved ties are not used, but the engineer believes it would be much more economical to do so, in which he is most probably correct.

Chicago, Burlington & Kansas City Ry.—The oak ties cost 42 cts. on the ground, but are charged out at 50 to 54 cts. on account of hauling and handling.

Chicago, Rock Island & Pacific Ry.—Hemlock ties treated by the burnetising (zinc-chloride) process are largely used on the lines west of the Missouri River.

Cincinnati, New Orleans & Texas Pacific Ry.—Ties must have not less than 9 ins. heart face.

Denver & Rio Grande R. R.—The ties are of red spruce, yellow pine, pinon or cedar; width of face, 7 to 11 ins.; thickness, $6\frac{1}{2}$ to $7\frac{1}{2}$ ins.; length, 8 ft. for standard and 6 ft. 6 ins. for narrow gage.

Duluth, South Shore & Atlantic Ry.—Hemlock ties are used on curves and cedar ties on tangents. They cost 18 to 22 cts. each, delivered on the roadway.

Flint & Pere Marquette R. R.—Cedar ties are 7×7 ins.; oak and hemlock, 6×8 ins. The cost is 24 cts. for cedar, 16 cts. for hemlock, and 40 to 45 cts. for oak, but there are not many oak ties left.

Florida Central & Peninsular R. R.—Pine and cypress are used, the latter being preferred; they cost $22\frac{1}{2}$ and 25 cts., respectively.

Gulf, Colorado & Santa Fe Ry.—Cypress, oak and pine are used as climate, supply, and track conditions suggest: the cost at distributing point is 44, $33\frac{1}{3}$ and 32 cts., respectively.

Illinois Central R. R.—White oak is used, ex-

Seaboard Air Line.—The preservation of ties is under consideration.

Southern Ry.—Oak ties are used wherever possible; and pine ties in the Southern country.

Southern Pacific Ry. (Atlantic System).—Between Algiers, La., and Houston, Tex., 360 miles, the ties are of cypress, 7×9 ins., 9 ft. long, costing 33 to 34 cts.; between Houston and El Paso the ties are of burnetised long leaf yellow pine, 6×8 ins., 8 ft. long, costing 28 to 29 cts. each.

Southern Pacific Ry. (Pacific System).—The ties are of California redwood, pine and fir, all pine and fir ties being treated by the burnetising (zinc-chloride) process.

Union Pacific Ry.—Oak ties, at 50 cts. each, are used on the Eastern Division; mountain pine ties, at 43 cts. each, on the Western Division.

Tie-Plates.

A., T. & S. F. Ry.—A number of Servis and Goldie tie-plates are in use, principally as substitutes for rail braces on curves. The Wolhaupter and other tie-plates are being tried experimentally on bridges, and at isolated points.

Boston & Albany R. R.—The Servis, Churchward and Goldie claw tie-plates are used. Up to last year they were placed on every tie when laying new rails, but last year they were laid only on every tie on curves.

Chesapeake & Ohio Ry.—The Servis and Goldie tie-plates are used, and where used they are placed on every tie.

Chicago & West Michigan Ry. (and Detroit, Lansing & Northern R. R.).—The few tie-plates used are of the Servis pattern, and are placed on every tie.

Chicago, Burlington & Kansas City Ry.—Tie-plates are used pretty generally on truss bridges with pine ties, the ties on bridges being spaced 12 ins. c. to c. The plates are of Servis (Q. & C. Co.), and Goldie (Dilworth, Porter & Co.) makes.

Chicago, Rock Island & Pacific Ry.—Servis and

TABLE A.—STANDARDS FOR RAILS, SPIKES, JOINTS AND TIES (1896).

	Railways.	Standard Rail. Weight per yard. Lbs.	Spikes. Size. Ins.	Rail Joints. Type.	No. of Bolts.	Size of Bolts. Ins.	Length of Angle Bars. Ins.	Spacing of Bolts. Ins.				Ties. Wood.	Size. Width. Ins	Thickness. Ins.	Length. Ins.	Cost. Cents.	No. per 30-ft. Rail.	Preservative Process.	
1	Atchison, Topeka & Santa Fe	67, 75	$5\frac{1}{2}$x9-16	3-tie / Bridge.	6 / 4	$\frac{3}{4}$	22 to 38		5	5	5	Oak, mtn. pine, red / spruce.	8	6	8	30 to 42	18	Wellhouse.	1
2	Baltimore & Ohio	80	5x9-16	Susp.	6	$\frac{3}{4}$x4$\frac{3}{8}$	30	6	5	4	5 6	Oak.	7 / 7	7 / 7	8 / 8½	....	15, 16	None.	2
3	Boston & Albany	95 (replac'g 72)	$5\frac{1}{2}$x9-16	Supp.	4	$\frac{3}{4}$	20		4$\frac{3}{4}$	4$\frac{3}{4}$	4$\frac{3}{4}$	Chest. (some / Hard pine.)	7 / 8	7 / 7	8 / 8	50 to 55 / 49	15	None.	3
4	Boston & Maine	75	$5\frac{1}{2}$x9-16	Susp.	4	$\frac{3}{4}$	24		6	6	6	Cedar, chestnut.	8	6	8	30 to 45	16	None.	4
5	Burl., Cedar Rap. & Northern	80 (replac'g 50)	$5\frac{1}{2}$x9-16	Susp.	4	$\frac{7}{8}$x4$\frac{3}{8}$	24		6	6	6	White oak. / Cedar.	8 / 8	6 / 6	8 / 8	45 / 36½	17	None.	5
6	Central of Georgia	70	$5\frac{1}{2}$x9-16	Susp.	4	$\frac{3}{4}$	28		5	8	5	White oak, mtn. pine.	9	7	8	22 to 24	16	None.	6
7	Central New Jersey	80	5-16x9-16	Susp.	6	....	30	5	4	4	4 5	W. oak, chest., yel. pine.	9½	8	8½	....	16	Few creos.	7
8	Chesapeake & Ohio	100 / 75	$5\frac{1}{2}$x9-16	Susp.	6	$\frac{7}{8}$ 4$\frac{3}{8}$ / $\frac{3}{4}$x3$\frac{7}{8}$	34	6	5	4	5 6	White or chestnut oak.	9	7	8½	30	16	None.	8
9	Chicago & Alton	80	5x9-16	Susp.	4	$\frac{7}{8}$x4½	26		6	6	6	White oak.	8	6	8	45 to 50	17	None.	9
10	Chicago & Northwestern	80	....	Susp.	4	$\frac{7}{8}$	24		6	6	6	W. oak, cedar, tam.	8	6	8	....	16 to 17	None.	10
11	Chic. & W. Mich. (and Det. L. & N.)	70	$5\frac{1}{2}$x9-16	Susp. / 3-tie	4 / 6	$\frac{3}{4}$x4	26		6	6	6	Oak, hem., tam., cedar.	6 to 12	6	8	Oak. 30 to 40 / Others 15 to 20	16	None.	11
12	Chicago, Burlington & Kansas City	75, 65	$5\frac{1}{2}$x9-16	3-tie	6	$\frac{7}{8}$x4	38	6	6	6	6 6	Oak.	8	6	8	42	18	None.	12
13	Chicago, Burl. & Quincy	75 (65 on some branches.)	....	3-tie	6	$\frac{7}{8}$x4	38	5	5	5	5 5	Oak.	8	6	8	52	18	None.	13
14	Chicago Gt. Western	75 / 60	$5\frac{1}{2}$x9-16 / $5\frac{1}{2}$x9-16	Susp. / Susp.	4 / 4	$\frac{7}{8}$x4$\frac{1}{2}$ / $\frac{3}{4}$x3$\frac{1}{2}$	26 / 22		6 / 4$\frac{1}{2}$	6 / 4$\frac{1}{2}$	6 / 4$\frac{1}{2}$	White oak.	8	6	8	44	17	None.	14
15	Chicago, Mil. & St. Paul	85, 80 (60, 65, 75 in use)	$5\frac{1}{2}$x9-16	3-tie	6	$\frac{3}{4}$x4	40			....		White oak. / Cedar.	8 / 7	6 / 7	8 / 8	....	16 to 18	None.	15
16	Chicago, Rock Id. & Pacific	60	$5\frac{1}{2}$x$\frac{5}{8}$	Susp.	4	....	22		5	5	5	Oak, cedar, burnet. hem.	8	6	8	40 to 50	17 to 18	Burnetising	16
17	Cincinnati, N. Orl. & Tex. Pac	75 / 60	....	Susp. / Susp.	6 / 4	$\frac{3}{4}$ / $\frac{3}{4}$	30 / 24	4$\frac{3}{4}$	4$\frac{3}{4}$ / 6	4 3-16 / 6$\frac{1}{4}$	4$\frac{3}{4}$ / 6	White oak, / Chest. oak.	9 / 9	7 / 7	8½ / 8½	26 / 26	14 / 16	None.	17
18	Clev., Cin., Chic. & St. Louis	80 (67 on less import. divs.)	$5\frac{1}{2}$x$\frac{5}{8}$	Susp.	6	$\frac{3}{4}$x4	30	6	5	4	5 6	White oak.	8	7	8	33 to 35	16	None.	18
19	Delaware, Lack. & Western	80, 75, 67	....	Susp.	6	$\frac{3}{4}$	30	4$\frac{3}{4}$	4$\frac{3}{4}$	4$\frac{1}{8}$	4$\frac{3}{4}$ 4$\frac{3}{4}$	Chestnut, oak.	7	7	8½	....	17	None.	19
20	Denver & Rio Grande	85, 75, 65	$5\frac{1}{2}$x9-16	Supp. & / 3-tie	4 & 6	$\frac{3}{4}$ & $\frac{7}{8}$	24 to 40		(See note s.)			Red sp., yel. p., pinon / and cedar.	7	6½	8	....	17	None.	20
21	Duluth, So. Sh. & Atlantic	72 (10 miles) / 60	5x9-16 / 5x9-16	3-tie / 3-tie	6 / 4	$\frac{3}{4}$x4 / $\frac{3}{4}$x3$\frac{1}{4}$	44 / 24	8$\frac{3}{4}$	6½ / 5	5¼ / 6¼	6½ 8¾ / 5	Hemlock, cedar.	7	7	8	18 to 22	17	None.	21
22	Erie	80 (some 90)	$5\frac{1}{2}$x9.16	Susp.	6	$\frac{3}{4}$x4$\frac{1}{4}$	30	4$\frac{3}{4}$	4$\frac{3}{4}$	4 3-16	4$\frac{3}{4}$ 4$\frac{3}{4}$	W. oak. / L-leaf yell. pine.	9 / 9	7 / 7	8½ / 8½	60 to 67 / 48 to 57	16	None.	22
23	Flint. & Pere Marquette	70	$5\frac{1}{2}$x9-16	Susp.	4	$\frac{3}{4}$	24		5	6	5	Oak, hemlock. / Cedar.	8 / 7	6 / 7	.. / ..	(See note.)	16, 17	None.	23
24	Florida Central & Peninsular	70, 58	$5\frac{1}{2}$x9-16	Supp. & / Susp.	4	$\frac{3}{4}$	24			....		Cypress, hemlock, pine.	(Note.)			22½, 25	18	None.	24
25	Great Northern	80, 75, 68	6x5-16	Supp.	6	$\frac{3}{4}$x3$\frac{5}{8}$	36	7	4½	4½	4½ 7	Oak, fir, tam., pine.	8	6	..	....	16	None.	25
26	Gulf, Colo. & Santa Fe	66	....	Susp. & / Bridge.	4	$\frac{3}{4}$x3½	24		5	5	5	Cypress. / Pine. / Oak	8 / 8 / 8	6 / 6 / 6	8 / 8 / 8	44 / 32 / 33⅓	17	None.	26
27	Illinois Central	75	$5\frac{1}{2}$x9-16	Supp.	4	$\frac{3}{4}$x4	20		4½	4½	4½	White oak. / Black and red cypress.	8 / 9	6 / 7	8 / 9	30 to 60	18	None.	27
28	Kan. City, Ft. Scott & Memphis	75	5x9-16	Various.	4	$\frac{3}{4}$	19 to 24		5	5	5	Oak.	8	6	8	30	17	None.	28
29	Lake Erie & Western	75, 60	$5\frac{1}{2}$x9-16	Susp.	4	3¼x3½	24		5	5½	5	Oak.	8	6	8	40	(2,700 to 3,000 per mile.	None.	29
30	Lake Shore & Mich. Southern	80	$5\frac{1}{2}$x9-16	Susp.	6	$\frac{3}{4}$x4¼	32	5	5	5	5 5	Oak.	8	7	8½	55	15	None.	30
31	Lehigh Valley	90, 80, 76	$5\frac{1}{2}$x9-16	Susp.	6	$\frac{7}{8}$x4$\frac{3}{4}$	28	4	4	4	4 4	Oak. / Yellow pine.	9 / 9	7 / 7	8½ / 8½	65 / 50	16	Few creos.	31
32	Louisville & Nashville	70	....	Supp.	4	$\frac{3}{4}$x1¼	22		6	6	6	Oak, yellow pine, cyp.	9	7	8½	20, 50	16, 17	None.	32
33	Lou., N. A. & Chicago	75 (33 ft.)	$5\frac{1}{2}$x$\frac{5}{8}$	Susp.	4	$\frac{3}{4}$x4	26		4	8	4	White oak.	8 to 11	6	8	37½	18 (33 ft.)	None.	33
34	Michigan Central	80, 65	$\frac{5}{8}$	3-tie	6	$\frac{3}{4}$	44	9	6	6	6 9	....	10	6	9	....	16	None.	34
35	Minn., St. P. & S. S. M.	72, 60	$5\frac{1}{2}$x9-16	Susp. / 3-tie	4 / 6	$\frac{3}{4}$ / $\frac{7}{8}$	23 / 40	6	4½ / 6½	7 / 7	4½ / 6½ 7	Oak. / Cedar. / Tam., hem.	7 to 8 / 8 / 8	6 / 7 / 7	.. / .. / ..	40 to 43 / 22 / 17½	17, 18	None.	35
36	Mo., Kan. & Tex.	75, 66 / 63	.... /	Susp. / Supp.	4 / 4	.... /	24 / 36		5 10	5 7	5 10	White oak.	8	6	8	35	21	None.	36
37	Missouri Pacific	75	$5\frac{1}{2}$x9-16	Susp.	6	$\frac{3}{4}$x4$\frac{1}{8}$	34	6	5	5	5 6	Oak.	8	6	8	25, 32	17	None.	37
38	Nash., Chatt. & St. L.	68	$5\frac{1}{2}$x9-16	Susp.	4	$\frac{3}{4}$x4¼	22		6	6$\frac{1}{8}$	6	White and post oak.	8 to 10	7	8½	30	16	None.	38
39	New York Central	100, 80	$5\frac{1}{2}$x9-16 and screws	3-tie	6	$\frac{3}{4}$	36	5.6	5 6	5.6	5.6 5.6	Yell. pine, oak, chest.	9	6	8	45, 53	16	None.	39
40	N. Y., N. H. & Hartford	100 / 78, 74, 70	$5\frac{1}{2}$x9-16 / $5\frac{1}{2}$x9.16	Susp. / Susp.	4 / 4	$\frac{7}{8}$ / $\frac{3}{4}$	24		7	5	7	White oak and chest.	6	6	8	40	18	None.	40
41	N. Y., Ont. & Western	76	$5\frac{1}{2}$x9-16	3-tie	4	$\frac{7}{8}$	36		9	9	9	Hard pine & chestnut.	9	6	8	40	18	None.	41
42	Norfolk & Western	85 (replac. 67)	$5\frac{1}{2}$x9-16	Susp. & / Lridge.	6	$\frac{3}{4}$	30	5	5	5 5-16	5 5	White oak.	7 to 9	7	8½	28, 38	16	None.	42
43	Northern Pacific	66, 56	....	Supp.	4	....	24		6	6	6	Oak, tam., fir.	9	7	8	23, 35	17	None.	43
44	Pennsylvania	100, 85, 70, 60	6x$\frac{5}{8}$	Susp.	6	1 & 13-16	34	6	5	4	5 6	White oak.	7	7	8½	....	14, 16	Experimt.	44
45	Penna. Lines West of Pittsburg	85 (branches 70)	$5\frac{1}{2}$x$\frac{1}{2}$x5- 6	Susp.	6	13-16	34	4	5	4	5 6	Oak.	8	7	8½	50	14 (85 lb.) / 16 (70 lb.)	Experimt.	45
46	Philadelphia & Reading	90, 80	6x1$\frac{1}{8}$	Susp.	6	$\frac{7}{8}$	30	5	4	4	4 5	Oak, yellow pine.	7	7	8½	60, oak.	16	None.	46
47	St. Louis Southwestern	75	$5\frac{1}{2}$x$\frac{5}{8}$	3-tie	6	$\frac{7}{8}$	40	6	6	6	6 6	Oak.	8	6	8	25	17	None.	47
48	Seaboard Air Line	66	$5\frac{1}{2}$x9-16	Bridge & / Supp.	4	$\frac{3}{4}$x4	24		3	6	3	White oak.	9	7	8	30	16	None.	48
49	Southern	80, 75	9-16	Susp.	4	$\frac{7}{8}$	26		7	4	7	Oak, pine.	9	7	8½	22, 40	16	None.	49
50	Southern Pacific (Atl. Syst.)	75	$5\frac{1}{2}$x9-16	Susp.	4	$\frac{3}{4}$x4	24		5½	5½	5½	Cypress. / Burnetised pine.	9 / 8	7 / 6	8 / 8	33, 34 / 28, 29	16	Burnetising	50
51	Southern Pacific (Pac. Syst.)	75	$5\frac{1}{2}$x9-16	Susp.	4	$\frac{3}{4}$x4	24		5½	5½	5½	Cal. redwood, pine, fir.	8	7	8	18 to 40	16	All p. & fir burnetised.	51
52	Union Pacific	75, 70	$5\frac{1}{2}$x9-16	Supp.	6	$\frac{3}{4}$	40	7¾	5½	5½	5½ 7¾	East Div., Oak. / West. Div., Mtn. pine.	8 / 8	6 / 6	8 / 8	50 / 43	17	None.	52
53	Wabash	80 (63, 70 in use)	....	3-tie	6	....	44	9	6	5	6 9	White oak.	8	6	8	41	16	None.	53

TABLE B.—STANDARDS FOR BALLAST, FROGS, SWITCHES, ETC (1896).

Guard rails on

TABLE B.—STANDARDS FOR BALLAST, FROGS, SWITCHES, ETC (1896).

Railway.	Tie plates.		Ballast.		Frogs.				Switches.				Guard rails on curves.		
	Make.	Number	Kind.	Depth under ties. Ins.	Standard pattern.	Spring rail or rigid.	Nos. for main track	Nos. for yards.	Pattern	Length of switch rail Ft	Sharpest turnout in main track Deg.	Auto. sw. stand or spring in switch rod	Foot Guard.	Flange way. Ins.	Used on what Curves. Deg.	
1 Atch., Top. & S. F.	Serv., Goldie.	....	B. St., Slag., Bt. Cl., Grav	10	Clamp and key.	Rigid.	9	9, 6½	Split.	15	15°	Neither.	Wood & C. I.	1⅜	12 to 20°	1
2 Balt. & Ohio	Servis.	....	B. Stone.	...	Key and bolt.	Sp. ri.	6, 8	....	Split.	15	412 & 495 ft.	....	Yes.	2¼	....	2
3 Boston & Albany	Ser., Gold. & Churchw'd.	Every tie on curves.	Gravel.	24	Bolted.	Rigid.	8, 10	6, 7, 8, 10	Split.	15	10	Auto. s. s.	Hart.	....	12° & over.	3
4 Boston & Maine	None.	None.	Gravel.	12	Bolted.	Rigid.	10	8	Split.	15	6	Auto. s. s.	Hart.	1⅜	No fix'd rule	4
5 Burl., C. Rapids & Nor.	Few sample lots.		Grav., Cind.. B. St., Bt. Cl.	10 6	Clamp or key.	Sp. m trk. Rigid.	9	9, 6.4	Split. Stub.	15 20, 25	15	Auto. s. s.	Hart.	5	Over 18°	5
6 Central of Georgia	None.	None.	Br. St., Slag, Grav., Earth.	6	Keyed.	Rigid.	9½	7	Split.	18	6° 42'	Auto. s. s.	None.	None.	None.	6
7 Central New Jersey	....	....	Br. St., Slag.	8	Bolt., Riv. plate.	Rigid.	10	....	Split.	....	....	Both.	....	....	....	7
8 Chesapeake & Ohio	Serv., Goldie.	....	Br. St, Grav. Slag.	12	Bolted.	Sp. ri.	10	7	Split.	15	....	Neither.	Yes.	....	....	8
9 Chicago & Alton	None.	None.	Br. St. Grav. S.ag.	12 to 15	Bolted (steel filled)	Sp, m trk Rig., yds.	9	9, 6½	Split and Wharton.	15 to 18	7° 30'	Auto. s. s.	Wood.	2	4	9
10 Chicago & Northwestern	Experiment.	....	Br. St., Grav.	12	Bolted.	Sp. ri.	10	6½, 7, 8	....	20	300 ft.	Auto. s. s.	Wood & Hart.	No	None.	10
11 Chic. & W. Mich. (and Det, Lan. & Northern	Servis.	1 to each tie when used.	Grav., Sand, Cinders.	6	Riv. plate.	Sp. ri.	10	5, 8	Split.	15	....	Auto. s. s.	Hart.	1¾ to 2	....	11
12 Chic., Burl. & Kan. City	Serv , Gold.	....	Bt.Cl. Br st., Cheri, Earth	6 to 12	Bolt. and riv.	Sp. ri.	10, 11, 15	6, 7	Split.	15	40°	Auto. s. s.	Oak.	2	15°	12
13 Chic., Burl. & Quincy	None.	None.	Grav., Bt. Cl.	8 to 12	Bolted.	Sp. in m. track except 15.	9, 11, 15	6, 7, 9	Split.	15, 24	20°	Auto. s. s.	Wood.	3	....	13
14 Chic. Gt. Western	None.	None.	Grav., Br. St.	6 to 9	Riv. plate.	Rigid.	9	9, 7	Split.	15	9° 30'	Auto. s. s.	Wood.	3	Few 20°	14
15 Chic., M'l. & St. Paul	Few Servis.	On every tie.	Gravel.	12	Riv. plate.	Sp. ri.	10	8	Split.	15	12	Au. s.s. on dbl. track; others rigid.	Hart.	3	12 to 17°	15
16 Chic., Rock Id. & Pacific	Serv., Gold.	On some curves.	Br. St., Earth.	6 to 12	Bolted.	Rigid.	10	7	Split.	15	....	Auto. s. s.	....	....	....	16
17 Cin., New Or. & Tex. Pac.	Few Servis.	On every tie.	Grav., Br. St., Slag.	12	Bolted.	Both.	10 9	7 7	Split and Wharton.	18, 15	7° 44'	Neither.	Wood.	7	2° or more.	17
18 Clev., Cin., Ch. & St. L.	Only in special localities.		Grav., Slag.	12	Bolted.	Sp. ri.	10	8 and special	Split and Wharton.	18 m. t. 15 yds.	....	Auto. s. s.	....	....	20° & over.	18
19 Del., Lack. & Western	None.	None.	Gravel.	12	Riveted.	Sp. ri.	10	8	Split and Wharton.	15	....	Sp. sw. rod	None.	1⅞	....	19
20 Denver & Rio Grande	Servis.	Every tie on curves.	Grav., Br. Stone, Slag.	10	Bolted.	Rigid.	8½	8½	Sp. for 85 lb.	15	8° 56'	Auto. s. s.	None.	....	....	20
21 Del., So. Sh. & Atlantic	None.	None.	Gravel.	8 to 24	Bolted.	Rigid.	9, 10	7, 8, 9	Split. Stub.	15 20	8°	Neither.	Wood.	2½	16° & over.	21
22 Erie	Servis.	Curves & br'ges.	Br. St., Slag. Cinders.	12	Bolted.	Sp. ri.	10	8, 6½	Split.	18	14° 20'	Au. s.s. form t.	None.	No.	None.	22
23 Flint. & Pere Marquette	Ser. & Gold	....	Gravel, Sand.	8, 12	Bolted.	Sp. ri.	8 to 9	7 to 9	Split.	15	10°	Auto. s. s.	Hart and Blocks.	No.	None.	23
24 Florida Cen. & Penin	None	None.	Sand.	....	Bolt., key.	Sp. ri.	9	9	Split.	15	....	Auto. s. s.	None.	No.	None.	24
25 Great Northern	None.	None.	Br. St., Grav.	8 to 16	....	Rigid.	9	7	Split.	20	7° 30	Neither.	Wood.	No.	None.	25
26 Gulf, Colorado & S. Fe	Expt.	....	Grav , Br. st.	10	Bolted.	Rigid.	9	9	Split.	15	6½ to 9	Neither.	None.	2½	20°	26
27 Illinois Central	Servis.	(Note.)	Br. St., Grav.	10 to 12	Riveted.	Sp. and Rig.	10	7, 10	Spnt.	15	....	Neither.	Yes.	No.	None.	27
28 Kan. C., Ft. Scott & Mem.	Gold & ser.	(Note.)	Br. St.	12	Bolted.	Sp. ri.	7, 9	7, 9	Split.	15	15°	Neither.	Hart.	1⅞	Over 15°.	28
29 Lake Erie & Western	None.	None.	Grav., Cind., Earth.	6	Riveted.	Mostly rigid.	9	7	Split.	15	22°	Auto. s. s.	Wood.	3	Over 16°.	29
30 Lake Shore & Mich So.	None.	None.	Gravel	At least 6	Bolted.	Sp. ri.	10	8	Split.	15	6°	Neither.	....	No.	None.	30
31 Lehigh Valley	Serv., Gold., Churchw'd.	(Few.)	Cind., Slag, Gravel.	6, 18	Plate.	Sp and Rig.	8, 10	6, 7, 8	Split.	15, 21	18°	Auto. s. s.	None.	No.	None.	31
32 Louisv. & Nashville	Various, at sp. points only.		Br. St., Sand, Grav., Slag	6, 12	Keyed.	Both.	9½	7	Split.	15	....	Auto. s. s.	(See note.)	....	....	32
33 Lou., N. A. & Chicago	None.	None.	Grav., Br. St.	6, 12	Bolted.	Sp. ri.	10	8	Split.	15	6°	Neither.	Wood.	1⅞	12° & over	33
34 Michigan Central	None.	None.	Gravel.	12	Bolt and key.	Both.	7, 9, 11, 14	5, 6, 7, 9, 11	Split.	15, 22	6°	(Note.)	Wood.	No.	None.	34
35 Minn., St. P. & S. S. M.	None.	None.	Gravel.	12	Clamp.	Rigid.	9	7	Split.	15	8°	Neither.	Wood.	12	....	35
36 Mo., Kan. & Tex.	None.	None.	Br. St., Grav.	6	Bolted.	Both.	9	No. sta'd.	Split.	15	7° 30'	Auto. s. s.	Wood.	2¼	15° & over.	36
37 Missouri Pacific	None.	None.	Br. St., Grav , Cind.	10 12	Clamp.	Sp. ri.	9	6, 7	Split.	15	7° 30'	Neither.	Wood.	1⅜	24° & over.	37
38 Nash., Chatt. & St. L.	None.	None.	Br. St., Slag, Grav.	12	Riv. plate.	Sp. ri.	6, 9	6, 8, 9	Split.	15	13½	Sp. sw.rod	None.	No.	None.	38
39 New York Central	Servis.	On joint tie.	Br. St., Grav.	12	Riv. plate.	Both.	10	7	Split.	15	875 ft.	Sp. sw rod.	Wood.	1⅜	250 ft. & under	39
40 N. Y., N. H. & Hartford	Servis.	(Note.)	Br. St., Grav.	14	Bolted.	Both.	10	7, 8	Split.	15	7° 30'	Both.	(See notes.)	(See notes.)	(See notes.)	40
41 N. Y., Ont. & Western	Goldie	....	Cind., Culm. Grav.	....	Bolted.	Sp. ri.	9	8	Split.	15	17°	Auto. s. s.	No.	1⅞	16°	41
42 Norfolk & Western	Servis.	Every tie on curves.	Br. St., Slag.	10	Riv. plate.	Sp. ri.	9	7, 8	Split.	18	7½, 9½°	Auto. s. s.	National.	2⅜	11° and 12°.	42
43 Northern Pacific	....	....	Sand, Grav., Cinders	6 to 12	Clamp.	Rigid.	9	7	Split.	15	655 ft.	....	Wood.	No.	None.	43
44 Pennsylvania	Pa. R R.	....	Br St., Grav, Cinders.	8	Bolt and key	Both.	8 to 30	6 up	Split.	18, 24, 30	16°	Neither.	....	2	....	44
45 Penna. Lines W. of Pitts.	Experiment.	....	Br. St	10	Bolt and key.	Sp. ri.	8, 10, 12	6, 8	Split.	15, 19	350 ft.	See note.		No.	None.	45
46 Phila. & Reading	None.	None.	Br. St., Slag, Cinders.	8 to 9	Clamp and bolt.	Both.	10	6, 8, 10	Split.	15, 18, 20	12°	Sp. sw.rod.	Spec. places only.	3½	....	46
47 St. Louis Southwestern	None.	None.	Br. St., Grav.	12	Keyed.	Both.	9	7, 9	Split.	12, 15	No. 7	Neither.	....	....	....	47
48 Seaboard Air Line	None.	None.	Gravel.	12	Riv. plate.	Sp. ri.	9	7	Split.	15	....	Auto. s. s.	None.	No.	None.	48
49 Southern	Servis.	On curves.	Br. St., Slag, Grav.	6	Bolted.	Sp. ri.	9	8	Split.	15	14°	Auto. s. s.	Note.	....	....	49
50 So. Pacific (Atl. Syst)	Servis.	....	Grav, Br. St, Earth.	7, 8	Keyed.	Sp. ri.	9	9	Split.	15	16°	Sp. s. r. Lorenz	None.	No.	None.	50
51 So. Pacific (Pac. Syst)	Servis.	32 per rail.	Br. St., Grav.	8	Bolted.	Sp. ri.	9	7½	Split.	15	11°	Auto. s. s.	None.	3	12° & over.	51
52 Union Pacific	Serv., Gold.	Curves.	Br. St, Grav, Cind , Bt. Cl.	10	Bolted.	Both.	10	7, 8½	Split.	15	6° 10'	Neither.	Hart.	No.	None.	52
53 Wabash	None.	None.	Grav., Bt. Cl., Br. St.	12	Riv. plate.	Sp. ri.	9	7	Split.	15	7° 31'	Neither.	....	No.	None.	53

Goldie tie-plates are used to some extent on curves.

Cincinnati, New Orleans & Texas Pacific Ry.—There are not many tie-plates used, and those are of the Servis pattern, two on each tie.

Denver & Rio Grande R. R.—The tie-plates are of the Servis pattern, and where used at all they are put on every tie on curves; they are not used on tangents.

Erie R. R.—Servis tie-plates are used on curves and bridges. There are from 12 to 16 tie-plates per rail length of track on curves, and two plates on each tie on bridges.

Illinois Central R. R.—Servis tie-plates are used on light curves, and are placed on every tie where used. This is a recently adopted standard, which has so far been applied only to cypress ties on the Louisiana Division, but it is expected to gradually extend it over the entire system. They are placed on every tie in switch leads where cypress ties are used, and on soft wood ties on curves under 3°.

Kansas City, Fort Scott & Memphis R. R.—Goldie and Servis tie-plates are used, and are placed on every tie at curves of 3° and over.

New York Central R. R.—Servis tie-plates are used, but are placed only on the middle or joint tie of the three-tie joints.

New York, New Haven & Hartford R. R.—Servis tie-plates are used on every tie at bridges and switches over which there is much traffic.

Norfolk & Western R. R.—The standard is the Servis tie-plate, and they are being used to a considerable extent this year on sharp curves, a plate on every tie being used in place of rail braces.

Pennsylvania R. R.—The P. R. R. pattern of tie-plate has no rib or claw to fasten it to the tie, but depends entirely upon the spikes for holding it. This does not seem to be good practice, though it is claimed that the rib or claw may damage a tie at the time when the plate should come into use to protect it.

Southern Ry.—Tie-plates are used on curves of upwards of 3°; those used thus far are of the Servis pattern.

Southern Pacific Ry. (Atlantic System).—The Servis tie-plate has been adopted as standard, two plates to each tie. The plates are 5×9 ins., with four ribs or flanges on the bottom, and four spike holes, 21-32 ins. square. The plates on the shoulder ties have three ribs and two spike holes to fit the angle bar slots.

Union Pacific Ry.—Servis and Goldie tie-plates are used; they are placed on curves only, two plates to each tie.

Ballast.

B., C. R. & N. Ry.—The depth of ballast under the ties is 10 ins. for gravel and cinders, and 6 ins. for burnt clay and broken stone, and the full depth is insisted upon. As the ballast has generally to be hauled a long distance, and is expensive, the tracks are put to sub-grade and the banks widened (so that no ballast will be wasted down the side of the bank) before the ballast is hauled onto the track. By putting the track to sub-grade with the material a very even depth of ballast is obtained, but where the track is raised several feet some settlement will take place, increasing the depth above given. All track is put up to grade stakes, one set on each side of the rail, 5 ft. from the center, generally at intervals of 100 ft. on tangents and 50 ft. on curves. The elevation is given by these grade stakes.

Chicago, Rock Island & Pacific Ry.—Most of the track on lines west of the Missouri River is ballasted with natural soil. Broken stone and various other materials are also in use.

Denver & Rio Grande R. R.—In some cases the entire roadbed is of disintegrated granite, which makes excellent ballast.

Erie R. R.—The standard depth under the tie is 12 ins. In reballasting, 3 to 4 ins. of ballast is put under the ties.

Florida Central & Peninsular R. R.—As much ballast is used as can be obtained; a large portion of the track has the entire roadbed of sand.

Gulf, Colorado & Santa Fe Ry.—Gravel is now being used, but there are about 100 miles of broken stone ballast, which was laid 3 to 6 years ago on the worst sections (on black soil).

Kansas City, Fort Scott & Memphis R. R.—Broken stone and tailings from zinc mine crushers are used.

Lehigh Valley R. R.—Anthracite cinders from locomotive fireboxes, furnace slag and gravel are used.

Louisville, New Albany & Chicago Ry.—In ballasting, at least 6 ins. is put under the ties, but the depth varies where it is necessary to raise the track to continue one uniform grade.

Minneapolis, St. Paul & Sault Ste. Marie Ry.—The ballast is mainly of gravel, there being also a very little broken stone.

Missouri Pacific Ry.—The ballast is of gravel, cinders, zinc tailings and broken stone.

Nashville, Chattanooga & St. Louis Ry.—The broken stone ballast is limestone; gravel and furnace slag are also used.

Norfolk & Western R. R.—The standard is broken stone or slag, but a considerable amount of gravel is also used.

Pennsylvania R. R.—The depth under the ties is not less than 8 ins. in main track, 4 ins. in sidings or on branch roads of minor importance.

Pennsylvania Lines West of Pittsburg.—Broken stone is standard, but gravel and slag are also used.

Southern Pacific Ry. (Atlantic System).—River bottom gravel is mainly used, broken stone where locally obtainable, and earth where there is no material for ballast. The standard depth is 15 ins. from top of tie.

Frogs.

A., T. & S. F. Ry.—The standard frogs are clamped and keyed, with solid fillers of wrought iron or steel, the angles being No. 9 for main line and Nos. 6½ and 9 for yards.

B. & O. R. R.—Yard frogs are of numbers to meet the requirements.

Chicago & Alton R. R.—The standard frogs are bolted, with steel filling. Spring rail frogs are used in the main track and rigid frogs in yards. For main track the standard is No. 9, with No. 6½ for crotch frogs. For yards, Nos. 6½ and 9 are used.

Chicago & Northwestern Ry.—Bolted frogs are used, and the Carter spring rail frog.

Chicago & West Michigan Ry. (and Detroit, Lansing & Northern R. R.).—The standard is a plate frog with rail riveted to it, spring-rail frogs being used for main track and rigid frogs for yards. The main track frogs are No. 10, with other numbers in special cases, but not less than No. 8. The yard frogs are No. 8, and in some cases No. 5.

Chicago, Burlington & Kansas City Ry.—Bolted and riveted frogs are used, with Nos. 10, 11 and 15 spring-rail frogs in main track and Nos. 6 and 7 rigid frogs in yards.

Chicago, Burlington & Quincy R. R. — Bolted frogs are used with Nos. 9 and 11 (spring-rail) and No. 15 (rigid) for main track, and Nos. 6, 7, and 9 for yards.

Chicago Great Western Ry.—All frogs are rigid, and are Morden U plate frogs, No. 9 for main tracks and yards, and No. 7 occasionally in yards when necessary.

Chicago, Milwaukee & St. Paul Ry.—Guard rails for spring-rail frogs are 15 ft. long, with 1 ft. at each end bent at about 45°, then a very slight curve of about 3 ft. long to the straight portion. The flangeway is 1⅞ ins. For rigid frogs, the guard rails are 10 ft. long, with 1 ft. at each end, bent at 45°, and the other part (8 ft.) has a gradual curve towards the center, not to exceed 1 in. in 8 ft.

Chicago, Rock Island & Pacific Ry.—The frog guard rails are straight, bolted to the main rails and spiked to the ties, the flangeway being 1¾ ins.

Cincinnati, New Orleans & Texas Pacific Ry.—The standards for main track are No. 9 for 60-lb. rails and No. 10 for 75-lb. rails. For yards, No. 7 is standard.

Cleveland, Cincinnati, Chicago & St. Louis Ry.—In yards, No. 8 is used most frequently, with special numbers to suit individual cases. The flangeway at frog guard rails is 2⅛ ins.

Denver & Rio Grande R. R.—The standard frogs for main track and yards are No. 8½ for standard gage and No. 9 for narrow gage. The flangeway at frog guard rails is 1¾ ins.

Florida Central & Peninsular R. R.—Spring-rail frogs are used in main track and rigid frogs in yards, No. 9 being the standard in both cases.

Gulf, Colorado & Santa Fe Ry.—The standard for main track is No. 9, with No. 6½ for the crotch frogs where a double turnout is necessary. In yards, No. 9 is used for leads, and No. 6½ on warehouse tracks where space is limited or expensive.

Illinois Central.—The standard main track frog on 1,500 miles of line is a spring-rail frog; on the remainder of the system rigid frogs are used.

Louisville, New Albany & Chicago Ry.—A No. 10 frog in main track practically fits a 6° curve on tangent, but, of course, after leaving the frog the curve can be compounded into almost any degree of curve. The flangeway is 1⅞ ins. on tangent, but on curves the gage of track is widened, the distance is increased to conform to the Master Car Builders' standard of distance between flanges of car wheels. The least degree of curve on which a guard rail is permitted is 12°.

Missouri, Kansas & Texas Ry.—The standards are a No. 9 bolted Elliot rigid frog, 15 ft. long, and a No. 9 Eureka spring-rail Elliot frog 15 and 18 ft. long. The guard rails are 15 ft. long, with a flangeway of 2¼ ins.

New York Central R. R.—For main track, the standard is No. 10, but a few of Nos. 7, 12 and 14 are used. For yards, No. 7 is standard, but Nos. 6 and 10 are used in special cases.

New York, New Haven & Hartford R. R.—The standard type is a bolted frog, with a spread of 10 ins. at the head and 5 ins. at the toe.

Norfolk & Western R. R.—The standard frog is of the spring-rail pattern, with rails riveted to a ¾-in. plate; this is the company's own design, and all other frogs used are also plate frogs. For main track, the standard is No. 9, or a somewhat lighter angle in special cases. Frog guard rails have a flangeway of 2⅛ ins.

Pennsylvania Lines West of Pittsburg.—The flangeway for frog guard rails is 2 ins.

St. Louis Southwestern Ry.—The Elliot keyed frog is the standard pattern, and Elliot spring and rigid frogs are used. The guard rail flangeway is 2½ ins.

Southern Ry.—Bolted frogs are used for the smaller sized rails and in yards, and the Eureka spring-rail frog for 75 and 80-lb. rails.

Union Pacific Ry.—Bolted frogs are used, with wrought iron filling. Rigid and spring rail frogs are in use, the latter are now beginning to be used in main track, and will probably be made the standard.

Switches.

A., T. & S. F. Ry.—Previous to 1893 the Wharton switch was the standard, but since then it has been the ordinary split switch and the Channel split switch. The sharpest turnout curve is 15° (on inside of curves), but is ordinarily 7° 30'. On main tracks rigid switch rods and switchstands are used, but a few automatic switchstands are used in yards.

B. & O. R. R.—The Mansfield switch with high target, and the Manning switch are used.

B. & A. R. R.—Some of the split switches are made by the company and others by the Ramapo Iron Works. Automatic switchstands are used.

B. & M. R. R.—The Ramapo switch is used.

B., C. R. & N. Ry.—The Channel switch, made by Pettibone, Mulliken & Co., of Chicago, is used. The length of switch rail is 15 ft. for split switches, and 20 to 25 ft. for stub switches.

Central of Georgia Ry.—The length of switch rail is 18 ft. for main track and 15 ft. for yards. The Ramapo automatic switchstand is used.

Central of New Jersey R. R.—Automatic switchstands are used, as well as springs in switch rods, to enable engines to trail through the closed switches.

Chesapeake & Ohio Ry.—A single-bar split switch is used, with reinforced tongue.

Chicago & Alton R. R.—Split and Wharton switches are used, with switch rails 15 and 18 ft. long. The sharpest turnout from main track is 7° 30', for a No. 9 frog.

Chicago & West Michigan Ry. (and Detroit, Lansing & Northern R. R.).—The standard split switch is of a pattern designed by the railway officers and made to order from rails furnished. The switch rail is 15 ft. long, except in a few cases, where a shorter rail is necessarily used. Turnouts are so located that standard frogs may be used; the frog and lead being located, and the turnout then started from the heel of the frog. The Ramapo automatic switchstand is used, but engines are only exceptionally allowed to trail through closed switches. The engineer does not favor the use of automatic switchstands, believing that the switch lever on the stand may be brought in place and locked without always bringing the switch rail close home against the main or stock rail.

Chicago, Burlington & Kansas City Ry.—The Clarke-Jeffery split switch is used in the main track and generally in the yards, the 15-ft. switch rails removed from the main track being cut down to 12 ft. for the yards.

Chicago, Burlington & Quincy R. R. — Split switches are used, of the Clarke-Jeffery pattern, with switch rails 15 and 24 ft. long. The sharpest turnout in main track is 20°, for a No. 5¾ frog. Automatic switchstands are used, but engines are not as a rule allowed to trail through a closed switch.

Chicago Great Western Ry. — The standard switch is the Clarke-Jeffery split switch, with 15 ft. switch rail. The Ramapo automatic switchstand is used instead of a spring in the switch-rod.

Chicago, Milwaukee & St. Paul Ry. — The switches and frogs are made by the company. The sharpest turnout curve in main track is about 12°, for a No. 8 frog. Automatic switchstands are used at all trailing switches on double track, but at all other points a rigid switchstand without any spring is used.

Chicago, Rock Island & Pacific Ry.—Several patterns are in use, but the road is now making its own switches, and uses the Ramapo automatic switchstand.

Cincinnati, New Orleans & Texas Pacific Ry.—The Weir Frog Co. and Wharton switches are used, with switch rails 15 ft. long for 60-lb. rails and 18 ft. for 75-lb. rails.

Cleveland, Cincinnati, Chicago & St. Louis Ry.—Wharton switches are used for high speed main track points, and split switches for low speed points and yards. The switch rails are 18 ft. long for main tracks and 15 ft. for yards. Automatic switchstands are used, but engines are not allowed to trail through closed switches.

Denver & Rio Grande R. R.—Stub switches are used, except with the 85-lb. rails, for which split switches are made in the company's shops. The length of switch rail is 15 ft., and the sharpest turnout curve in main track is 8° 26'. Automatic switchstands are used, but engines are not allowed to trail through a closed switch.

Duluth, South Shore & Atlantic Ry.—The split switches have the Morton rigid stand, and switch rails 15 ft. long. Stub switches have switch rails 20 to 22 ft. long in main track and 18 to 20 ft. long in yards.

Erie R. R.—The split switches have 18-ft. switch rails, 4 ins. throw, 5 rods, and 20 braces and plates. The Mansfield switchstand is used, which is automatic for the turnout, locked when closed to main track so as not to be automatic. No spring is used in the switch rod. The sharpest turnout curve on main track is 14° 20', at a junction where a slip switch is used.

Flint & Pere Marquette R. R.—The Ramapo split switch and automatic switchstand are the standards.

Florida Central & Peninsular R. R.—Various makes of split switches are in use, but mostly the Ramapo switch with automatic switchstand.

Great Northern Ry.—The standard switch is of the Whittemore pattern.

Gulf, Colorado & Santa Fe Ry.—Split switches of the Missouri Frog & Crossing Works' pattern are used in main track, with 15 ft. switch rails, and rigid adjustable switch rods. Stub switches in yards have 30-ft. switch rails, with 5 ft. spiked. The switchstands are of the Robinson pattern. There are a few turnouts of 15°, with No. 6½ frogs, in the terminal yards where all trains must run slowly; but besides these only No. 9 turnouts are used.

Illinois Central R. R.—The standard is a split switch of the company's design, with a 15-ft. switch rail in main track and 12 ft. in yards. No automatic switchstand or spring switch rod is used. The sharpest turnout curve in main track is that which fits a No. 10 frog.

Kansas City, Fort Scott & Memphis R. R.—The Elliot rigid stand is used, and automatic switchstands are being discarded.

Lehigh Valley R. R.—Low automatic stands are used in yards, but engines are not allowed to trail through closed switches.

Louisville, New Albany & Chicago Ry.—The switch rails are 15 ft. long, with a throw of 5 ins.

Michigan Central R. R.—The switches are of the company's own pattern and make, with switch rails 15 and 22 ft. long. A few automatic switchstands are used, but in yards only.

Minneapolis, St. Paul & Sault Ste. Marie Ry.—The standard split switch is of the Channel pattern, made by Pettibone, Mulliken & Co., of Chicago.

Missouri, Kansas & Texas Ry.—The standard is the Channel split switch, made by Pettibone, Mulliken & Co., of Chicago, and fitted with rigid connecting rods and a banner switchstand.

Missouri Pacific Ry.—The switches are of the Elliot Frog & Switch Works' pattern.

Nashville, Chattanooga & St. Louis Ry.—The Pennsylvania Steel Co.'s split switch is used, with Steelton detective switchstand and Lorenz spring switch rod.

New York Central R. R.—The standard split switch has a 15-ft. switch rail and a spring connecting rod. Automatic switchstands are also in use, but trailing through closed switches is contrary to orders. For yard switches the length of switch rail is 10, 12, and 15 ft. The sharpest turnout curves in main track are 395 ft. radius for a No. 7 frog, and 875 ft. for a No. 10 frog.

New York, Ontario & Western Ry.—The Pennsylvania Steel Co.'s split switch is used, with Ramapo safety automatic switchstand.

Norfolk & Western R. R.—The standard is a split switch of the company's design, having an 18-ft. switch rail, 3½ ins. throw, and equipped with five connecting rods, 20 raising plates and 14 rail braces. The Ramapo automatic switchstand is the standard for main line and yards. The sharpest curve in main track is 7½° with No. 9 frog, and in a few special cases it is 9½° with a No. 8 frog.

Pennsylvania R. R.—The length of switch rail for standard switch for turnout from main track is 18 ft.; switch rails 24 and 30 ft. long are used in running from main tracks into third or fourth track connections.

St. Louis Southwestern Ry.—The Elliot split switch is the standard on this road.

Southern Pacific Ry. (Pacific System).—The standard split switches are of the company's make.

Union Pacific Ry.—The standard split switch is of the company's design, with a rigid switchstand similar to the Elliot pattern.

Wabash R. R.—The standard switch is that of the Elliot Frog & Switch Co., with 15-ft. switch rail, and the sharpest turnout curve is 7° 31', for a No. 9 frog. No automatic switchstand or spring in switch rod is used, and engines are not allowed to trail through closed switches.

Footguards.

A., T. & S. F. Ry.—Wooden blocks are used at all frogs, and cast-iron blocks in guard rails.

Chicago & West Michigan Ry. (and Detroit, Lansing & Northern R. R.).—The Hart footguard is generally used; this is a piece of wood fitted and bolted to the rail, but a number of other devices have also been used.

Chicago, Burlington & Kansas City Ry.—The law requires the blocking of frogs, switch and guard rails, and this is done with oak pieces.

Cleveland, Cincinnati, Chicago & St. Louis Ry.—The frogs and guard rails are blocked with gravel, cinders, wood and metal devices.

Kansas City, Fort Scott & Memphis R. R.—Cast-iron footguards are used for frogs and guard rails; and wooden guards for switches.

Louisville & Nashville R. R.—Footguards are used where required by law.

Louisville, New Albany & Chicago Ry.—Wooden blocks are being experimented with.

New York, New Haven & Hartford R. R.—These are required by law only in Massachusetts.

Norfolk & Western R. R.—Footguards are used only in the state of Ohio, where the standard is the National footguard (Eng. News, Oct. 24, 1895), which is gradually displacing the old wooden guards.

Pennsylvania Lines West of Pittsburg.—They are used only where required by state legislatures.

Wabash R. R.—The National metal footguard is used, made at Columbus, O.

Southern Ry.—Footguards are used only on lines in Kentucky.

Guard Rails on Curves.

A., T. & S. F. Ry.—They are now placed to give a flangeway of 1¾ ins., but formerly the space was 1¾ to 2⅜ ins. There is no special rule as to the degree of curve on which to use them, but the flangeway is increased with the curvature as follows:

Degrees.	Ins.	Degrees.	Ins.	Degrees.	Ins.
1 to 2	1⅞	9 to 11	2¼	15 to 17	2½
3 to 5	2	12 to 14	2⅜	18 to 20	2⅝
6 to 8	2⅛				

B. & A. R. R.—Guard rails on sharp curves are placed as near to the track rails as the bases of rails will permit; guard rails opposite frogs have a flangeway of 1¾ to 2 ins.

Chicago, Burlington & Kansas City Ry.—These are not used on main line curves, but on some sharp turnouts with curves of about 15°, the flangeway being 2 ins.

Chicago, Burlington & Quincy Ry.—They are used on curves of 35°, but will be needed on curves of smaller degree also. The flangeway is about 3 ins.

Chicago, Milwaukee & St. Paul Ry.—They are used in a few instances on curves of 12 to 17° in main track, with a flangeway ordinarily of 3 ins. The idea is to leave sufficient room between the main and guard rail, so that wheels on this curvature will not come in contact with the guard rail unless they begin to tend to mount the outside rail.

Cincinnati, New Orleans & Texas Pacific Ry.—They are used only on curves of 2° or more, approaching bridges or dangerous places where a derailment would be disastrous. The flangeway is 7 ins., so that the guard rail does not come into action until the wheels have left the track rails.

Cleveland, Cincinnati, Chicago & St. Louis Ry.—Inside and outside guard rails are used on curves of 20° and over.

Denver & Rio Grande R. R.—On the standard gage system there are yard track curves of 24°, and no guard rails are used. The maximum curve on standard gage main lines is 12°. On the narrow gage system there are main line curves of 24°, and Y track curves of 32°, but guard rails are not used. Some time ago a 33° curve was operated, along which an extra rail was laid to carry blind tires of driving wheels, but this was not a guard rail in the sense in which that term is generally used.

Gulf, Colorado & Santa Fe Ry.—They are only used on a few industrial spurs, with curves of probably over 20°, and there the flangeway is 2½ ins.

Illinois Central R. R.—Guard rails are not used, but rail braces are used on all curves of over 3°, and tie-plates on soft wood ties on curves of under 3°.

Louisville, New Albany & Chicago Ry.—There are no guard rails on main track curves, but on some sidetrack curves of 12° and upward, the flangeway being 2 to 2½ ins.

Minneapolis, St. Paul & Sault Ste. Marie Ry.—Guard rails are used only at the St. Croix River bluffs, and are set 12 ins. from the main rail to catch wheels in case of derailment, so that, as on the Cincinnati, New Orleans & Texas Pacific Ry., they do not come into action until the wheels have left the track rails.

New York, New Haven & Hartford R. R.—The guard rails are laid as close to the track rails as the section of rail permits. The degree of curve on which they are used depends upon the engines which run over it.

Norfolk & Western R. R.—They are used on a few short sections of the road having curves of 11° and 12°, and the flangeway allowed is 2⅛ ins.

Pennsylvania R. R.—They are only used on sharp turnouts into warehouses and coal yards.

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CHAS. W. REINHARDT.....CHIEF DRAFTSMAN.

GEO. H. FROST, F. P. BURT.....BUSINESS MANAGERS.
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There are two methods in common use for proportioning the parts of engineering structures to the loads they have to bear. One method is to compute the strains to which each part will be subjected and make each part of a size which will enable it to safely carry the strain. The other is to make the part of whatever size appears about right, put it into service and see what will happen. If it breaks it is made larger. If it does not break the tendency to economy finally causes the reduction of the size to a point where breakages will begin to occur. The first method is a development of modern engineering; the second method is the one which has been employed ever since men first began to erect structures and build machines. In mechanical engineering especially, there are many cases where strains are so hopelessly complex that it is impossible to measure or estimate them; but progress is steadily increasing the use of the first method and is proving its applicability in places where its use would have been sneered at as fine-spun theory a generation ago.

There is a notable example of this substitution of the first method for the second in one of the reports presented at the Master Car Builders' meeting last week. The M. C. B. Association has at various times adopted standard dimensions for axles to be used under cars of various capacity, and these have been the results of the united experience of the members in the use of axles and the breakage of various sizes. Last year a committee was appointed to present designs for a standard axle for cars of 80,000 lbs. capacity. Very few cars of this capacity are now running, so the committee could not do as has been done in the past—merely select a standard which should be an average of the best practice. Instead, they undertook the difficult task of computing the strains in such an axle and adopting a form and section proportioned to safely withstand such strains. We have not seen a more admirable piece of work in scientific proportioning in difficult mechanical engineering practice than this in a long time. The report really comes near being a treatise on the design of railway car axles. Its length, unfortunately, prohibits its reprinting here; but any of our readers who may desire to procure a copy will probably be able to do so by addressing the Secretary of the Association (Mr. John W. Cloud, Rookery Building, Chicago). The extra copies of the separate report printed for use at the convention will be sent on request till the edition is exhausted, after which the report can be obtained by purchase of the volume containing the annual proceedings of the Association, which will be issued in the fall.

A correspondent calls our attention to a remarkably silly item, which has been going the rounds of the daily press, to the effect that the extreme lightness of a bicycle is due to the fact that it has a very small factor of safety, "as low in some cases as 1¼." The real state of affairs is, of course, that the "factor of safety" in a bicycle is a widely varying quantity, and must be of necessity in any structure subjected to such varying and indeterminate strains. The weight of the rider, for example, may be anywhere from 80 to upwards of 200 lbs., and extra weight in the shape of parcels or children may often be carried. Again, in passing over a rough road or pavement the machine is subjected to shocks which induce static strains in various parts that cannot possibly be determined by either theory or experiment. Talk about a "factor of safety of 1¼" in a bicycle, is, therefore, utter nonsense, the fact being that with a rider of average weight on a well-made bicycle the factor of safety is probably nearer ten times that amount.

That an earthwork slope should be more stable at a steep inclination of, perhaps, ½ to 1 than at a slope of 1½ to 1, seems a curious paradox; but in a letter in our correspondence column this week an engineer of much experience in tropical countries affirms that this is the case in such regions of heavy tropical rainfall as Nicaragua or Panama, and explains the reasons for this peculiar fact.

STANDARD TRACK CONSTRUCTION OF AMERICAN RAILWAYS, 1896.

During the past few years much has been written about the improvement of railway track in the United States, and in order to arrive at some definite idea as to the progress and extent of such improvement we commenced, some weeks ago, an investigation into the present standards of track construction as adopted by about 50 of the leading railways, the traffic conditions of which vary, of course, very considerably. These railways cover every section of the country, and the results of this investigation are given in full in another column.

The standards adopted do not as a rule represent the actual track construction over the entire main line mileage of the several railways, but only that of a portion of the mileage, which portion is gradually increasing as renewals are carried on to meet the requirements of traffic. The other and older portion of the existing track is in very varying condition as to material and maintenance, and it must be admitted that light and worn rails, decayed and worn ties, a heterogeneous collection of frogs, a skimped amount of ballast and other defects are too often to be seen on important lines. This is due largely to financial conditions (the various good and bad reasons for which we need not stop to consider) and to the fact that the transportation or traffic departments have in general received much more and much closer attention than the roadway department. On the other hand, some of our main lines have a track equal to the best in any other part of the world, well built and well maintained. The economy in maintenance expenses resulting from a substantial track construction increases in proportion to the traffic which is carried.

In regard to the rails, five companies specifically report that their standards are of the sections recommended by the rail committee of the American Society of Civil Engineers, and it will be seen that 75 and 80-lb. rails are becoming very general. In almost every case the standard length of rail is 30 ft., for though several roads are trying rails 33, 45 and 60 ft. long, only one reports a standard length greater than 30 ft., and that is the Louisville, New Albany & Chicago Ry., whose standard is a 33-ft. rail of the Am. Soc. C. E. 75-lb. section. In view of the great increase in traffic, wheel loads, speeds, etc., the present standards in weight of rails cannot be considered as more than meeting the demands for present requirements (with a very few exceptions), and it must be borne in mind that very few railways have their standard rail or standard track yet laid over more than a portion of their systems, while the lighter track has still to carry the increased traffic and loads, as already noted. It is this latter state of affairs which is responsible for so many of our railway accidents, and for the European prejudice against the American type of track.

The fastenings of the rails to the ties continue to be very unsatisfactory for heavy track and traffic, practically every road still using a 5½-in. nail or spike, ⅝ or 9-16-in. square. The few roads which have tried screw spikes use them to such a small extent as to practically cut no figure.

In rail joints there is a great diversity, but the very long splice bars for six bolts and three ties seem to be losing favor. The New York Central R. R. retains its 36-in. bars, but very few roads go beyond this length. The Lake Shore & Michigan Southern Ry. has abandoned its 48-in. bars for 32-in. bars, retaining its six bolts, and the Atchison, Topeka & Santa Fe Ry. has adopted the Heath bridge joint with 24-in. bars in place of a three-tie joint with 38-in. bars. Three roads (the Chicago & West Michigan Ry.; Minneapolis, St. Paul & Sault Ste. Marie Ry., and Wabash R. R.) with three-tie joints and angle bars 38, 40 and 44 ins. long, respectively, report against this type of joint and approve the bridge or suspended type with shorter bars. The Chicago & Alton R. R. also has adopted suspended joints for its 80-lb. rails in place of three-tie joints for its 70-lb. rails. Steel bolts are commonly used, and the Harvey grip-thread bolt (which obviates the necessity of using nut locks) is growing in favor. It is satisfactory to note the increasing adoption of the bridge type of joint, but there seems no reason for using a base support adopted for use as a bridge plate, and then putting a tie under the joint.

In view of the cost of untreated ties it seems strange that so little progress is being made with the introduction of treated ties of a cheaper quality of wood. Creosoted ties appear to be very little used, but ties treated by the zinc-chloride and zinc-tannin processes are used very extensively in the southwest, especially on the Atchison, Topeka & Santa Fe R. R., the Chicago, Rock Island & Pacific Ry., and the Southern Pacific Ry. The cost of first-class white oak ties on the Norfolk & Western R. R. is 28 to 38 cts., averaging 33 cts., and it is stated that at this low price it is not considered advisable to treat them. It is a question, however, whether a cheaper timber treated by some preservative process would not be really more economical. In fact, the engineer of the Chicago & West Michigan Ry. (which road pays 30 to 40 cts. for oak and 15 to 20 cts. for cedar, hemlock and tamarack) considers that it would be more economical to use treated ties. A treated tie of the cheaper wood, protected by tie-plates if the amount of traffic renders this necessary, would give probably longer and better service than the untreated tie of more expensive timber, leaving the latter timber available for other industrial uses. The use of tie-plates is steadily increasing, some roads using them for ties on curves and bridges only, or on joint ties, while other roads use them on intermediate ties, with 12 to 32 plates per rail length. The economies resulting from this practice can hardly be over-estimated. The Pennsylvania R. R. is practically alone in the use of flat plates, and as only the ordinary spike is relied upon to hold them down this cannot be considered as the best practice, in line with experience elsewhere. It is claimed that claws or ribs cutting into the tie would lead to injury to the timber, but this is not borne out by experience. The Southern Pacific Ry. used flat plates for this same reason, but after experimenting with flanged plates this latter type was definitely adopted. The great advantages of ribs or claws are in uniting the tie-plate firmly with the tie, without any reliance on the spikes or other fastenings. This latter road used screw spikes with its flat plates, but the Pennsylvania R. R. does not even use this improvement.

The ballast is mainly of gravel, a term which in-

cludes various grades of material, from that which is little better than earth or sand, to that which is practically as good as broken stone. Slag is an excellent material extensively used on roads passing through the iron regions; while burnt clay, which is very good for ordinary traffic, is used in the southwest. The tailings from crushers at the zinc mines are used on the Kansas City, Fort Scott & Memphis R. R., and Missouri Pacific Ry.

Spring rail frogs are becoming almost universal for main track use, their supposed dangers not having been found to exist in practice, while their advantages are very evident. There is a notable tendency to limit the number of frog angles, one or two being usually sufficient, and No. 9 and No. 10 are most common for main track work. In yards Nos. 7 to 9 are those usually specified as standards, but some roads specify the same for yards as for main tracks. It is to be hoped that roads follow out their adopted standards, and do not permit the continued use in renewals of the various numbers and odd sizes of frogs which have crept into use. There is still a considerable variation in width of flangeway at frog guard rails, in spite of the amount of attention and discussion which has been given to this subject in the attempt to secure some uniformity. It will be seen by the tabular record in another column that the split switch is practically universal as a standard, though the stub switch still continues to be rather too much in evidence in practice. The length of switch rail is usually 15 or 18 ft., but in some cases runs up to 20, 24, 25 and 30 ft., the latter on the Pennsylvania R. R. for connections with the third and fourth tracks. The Wharton switch is gradually disappearing, giving place to the ordinary type of split switch. Most roads use switches which can be thrown by an engine trailing through a closed switch, this being usually effected by an automatic switchstand, and less frequently by a spring in the switch rod connections, as in the Lorenz switch. As most of these roads have orders forbidding enginemen to trail through closed switches, it would seem better practice to follow the practice of the minority and use rigid switchstands and rigid connections. Only three roads report the throw of the switch, 4 ins. on the Erie R. R., 5 ins. on the Louisville, New Albany & Chicago Ry., and 3½ ins. on the Norfolk & Western R. R.

Footguards for blocking the heels of switches, ends of frogs and ends of guard rails are not used as much as they should be. These are to prevent men from getting their feet caught in these places, and being run over, and the amount paid for damages, law suits and pensions in a few years probably far exceeds the cost of putting in a permanent blocking. Many roads use them only in States where the law requires their use. Gravel filling is better than nothing, wood blocking (if properly maintained) is an improvement, but metal devices are the most satisfactory and economical. In New York State alone, during the year ending June 30, 1895, no less than 27 persons were killed or injured from this cause.

On the whole, the showing made by the tabular record may be considered as satisfactory, but the attention of managers and other higher officers should be called to the necessity for and advantages of the more rapid extension of improved standards for track construction.

LETTERS TO THE EDITOR.

The Nicaragua Canal Estimates.

Sir: I have read with much interest the report of the Nicaragua Canal Commission in your issue of March 26. I beg to hand you herewith a copy of a report which I made in 1887, comparing the Nicaragua and Panama canals, from which you will see that my estimate of the cost of the Nicaragua Canal does not differ greatly from that of the Board of Engineers. I may say that I fully approve of the larger estimate made by the board, as when my report was written I was given to understand that good foundations were to be found at the sites of the Ochoa and La Flor dams.

I still believe that the best method for making and maintaining a good port at Greytown would be by turning all the water of the San Juan River into the harbor once more. This, with a properly devised system of jetties, should be sufficient to scour out the harbor and maintain it at a sufficient depth at all times. The accompanying sketch shows the general direction of the winds and currents at this point. All the sand that is now brought down by the Colorado branch is carried up the coast by the drift and deposited behind the point in front of Greytown, while if this sand were brought down into Greytown harbor itself with the full current of the river it would be carried out to sea and drifted on up the coast in the direction of Monkey River. I believe that this subject is well worth a careful study, and am not aware that proper attention has been directed to it.

As long ago as 1888 I pointed out to Mr. Menocal the uselessness of the jetty as proposed by him to stop the drift of sand up the coast, and I now see from the report of the commission that exactly what I predicted has happened, as the sand has already filled in behind the jetty and is drifting around the end of it, and this will continue to happen no matter to what length this jetty may be extended, although, of course, a jetty could be extended far enough to stop the drift for many years.

A word with regard to the creosoted piling and timber used in this jetty. It should be noted that this timber was creosoted with wood oil, which from all that I have seen and heard of it, will not withstand the ravages of the teredo. For treating piling and timber for tropical waters nothing should be used but dead oil of coal tar, and this in a quantity of not less than 18 to 20 lbs. to the cubic foot. This I find stands very successfully the attacks of the teredo.

With regard to the port on the Pacific coast, Brito is certainly a miserable little hole. A canal like this should have a port capable of holding a large number of vessels at one time, for various reasons. To make such a port at Brito would be a very expensive affair, and I believe that

Direction of Winds and Currents at the Atlantic Mouth of the Nicaragua Canal.

further surveys should be made to demonstrate if it is practicable or not to carry the canal to Salinas Bay, which is a most magnificent harbor, and capable of holding the navies of the world.

I am not aware that anything more than a slight reconnoissance has been made of this route, and I believe that a careful topographical survey should be made between the lake and Salinas Bay so that an opinion could be formed as to the cost and practicability of this route. I think it would be well worth while to spend a few millions more on the canal in order to obtain the benefits of this most magnificent harbor.

I find that the rainfall on the Atlantic coast of Nicaragua is much greater than I had anticipated, but on the Pacific side it is certainly less than on the Isthmus of Panama. With regard to the slopes of the cuts and their being so slightly affected by the rainfall. I would say that that is the general experience of the writer and others in tropical climates; one principal reason for this being that there are no frosts to disintegrate the material for the rains to carry it away, and another that these slopes soon become covered with mosses and vegetation of different kinds which protect them from the rainfall. It is the general experience that a steep slope, from perpendicular to ½ to 1, will stand much better against the tropical rains than a slope of 1½ to 1, or flatter, as in the latter case a much larger surface is exposed to the direct fall of the rain and it is washed away much more rapidly. The writer has seen material in these countries which will stand much better at a slope of ¼ to 1, or even vertical, than it will at a slope of 3 to 1. Of course where the material cut through has clayey or slippery seams in it, which allow it to slide, slopes have to be made much flatter.

It is very surprising that the canal company has such a lack of some of the most essential data, as, until the report of the Board of Engineers, it has been generally understood that the surveys were most complete and detailed. I certainly hope that the United States Government will appropriate the sum indicated by the board and proceed at once to make complete surveys.

Since writing the above I have seen Mr. Menocal's reply to the report of the board, published in Engineering News of April 30, but I cannot say that his arguments change my opinion in the slightest degree.

Mr. Menocal's argument for a reduced cross-section for the canal may be very well from a "commercial" point of view, but it seems to be pretty well demonstrated that the money cannot be raised for a "commercial" canal, at least not for many years to come; and if government aid is to be invoked for its construction the canal should certainly be built of such dimensions as to easily pass our largest men-of-war in safety. Not but what I believe that this canal, once finished, will prove as great a commercial success as the Suez Canal, but I think that without government aid of some kind it will be impossible to raise the money for its construction.

With regard to the location of the ports at either entrance to the canal, I believe that the best location should be secured regardless of territorial lines, and as you well say in your editorial remarks, "the jealousy of petty Central American states should be set aside," and I may add that the government of the United States should have no difficulty in arranging these matters whenever competent engineering authority should decide on the proper location for the canal and its ports.

In conclusion, I would say, by all means let us have the most complete and thorough surveys, even if they cost $500,000 and three years' time, and do not let us make the mistakes of Panama by commencing work without knowing "where we are at" as regards some of the most serious problems connected with the construction of this important canal; doubly important to the United States, as it will virtually form part of our coast line.

Respectfully,

Slivanus Miller, M. Am. Soc. C. E.

Puerto Barrios, Guatemala, May 9, 1896.

Garbage Disposal in Germany.

Sir: In view of the present general interest in the question of garbage disposal, I hand you a condensed translation of three progress reports, sent to me by professional friends in Berlin, giving the results obtained by official experiments on garbage cremation. These experiments are not yet completed, but the reports are sufficiently comprehensive to indicate not only the ultimate results in a general way, but also the careful manner in which they are being reached. The account of the experiments is very refreshing reading when placed in contrast with the methods that have generally been followed.

Within the last few years I have had occasion to examine most of the garbage disposal plants at home and in Europe, and from a comparison it seems evident that unless we are willing to give the subject sufficient scientific consideration it is probable that we shall remain behind Europe in reaching economical and satisfactory solutions of this municipal question.

Hamburg has to-day the largest plant in the world for garbage disposal (F. Andreas Meyer, Chief Engineer). It is not an expensive plant, nor is the process expensive or in any way objectionable. Berlin, in connection with other German cities, and also several cities of France and Belgium, are making experiments, the results of which point to a satisfactory solution. England has had for many years a large number of plants in operation, most of which have given satisfaction. Seldom has a failure been recorded and then because of insufficient attention to details, either in construction or operation.

The failures in our country have been numerous. Several cremation plants have been abandoned, partly because of the nuisance created by the fumes of insufficiently-burnt organic matter, and partly because of the high cost, which was apparently required to accomplish a complete burning. A number of reduction works operated by private companies have been abandoned, also partly on account of the nuisance they created and partly because the revenue derived therefrom was insufficient to pay a fair interest on the invested capital, when the works had to be conducted in a sanitary manner. Quite recently one of the best managed and largest reduction plants in our country has been abandoned, and a cremation plant substituted by the company, purely for economical reasons. In addition to the inefficiency of some of our works, we usually also pay more for garbage destruction than is paid in Europe.

Such failures and the loss of much invested capital, and the long-endured nuisance of improperly disposing of our city garbage, are the result of not ascertaining in a scientific way the relative efficiency of the several methods and the best manner of operating the plants.

It is hardly possible to-day to get even a reliable mechanical analysis showing of what the garbage consists in the different cities, while in Europe this is one of the first items to be ascertained. There is too little attention given to the proper construction of the details of the furnaces. The firemen have too little experience, and not enough intelligence is displayed in the operation of screening, of applying the right quantity of fuel to the varying garbage as delivered from different districts, and to the regulation of the draft and temperature in the flue, so as to get the most economical results and at the same time avoid insufficient combustion during certain conditions of the atmosphere. It is not nearly as easy to burn garbage properly as it is to burn coal.

It is interesting to note that notwithstanding the inferiority of the Berlin garbage for purposes of cremation, compared with that of other European cities, the results are still considered fairly satisfactory and will probably lead to the eventual introduction of that method of disposal. Reduction processes such as are used in some of

our large cities have been condemned in Europe quite generally on account of their greater expense.

To properly solve the problem the initiative should be taken by the city authorities in this as in most other public matters. Before adopting any method they should first carefully ascertain by study or experiment which is the most efficient one for disposing of the garbage in their own city, respecting the demands of sanitation and economy. The initiative should not be taken by theorists or by parties who have patented systems and who, from the powerful motive of personal interest, actively exercise their persuasive powers upon the representatives of the people. They are, no doubt, honest in their belief that their own systems are good, and one of them may really be the best for the local conditions for which it is advocated. But before a community's money is invested in such new and sometimes large undertakings, it seems to be wise, in public as in private matters, to proceed in the only sure way of meeting success; by first making a thorough and impartial investigation so as to arrive at positive conclusions regarding the actual results that can be expected from the plant as it will be constructed and is likely to be operated. Instead of proceeding in this, the right direction, we have too often proceeded in the wrong direction, leading inevitably to disastrous results. Rudolph Hering.

277 Pearl St., New York, June 15, 1896.

(The report on garbage disposal at Hamburg, and on the experiments at Berlin, kindly sent by Mr. Hering, are given below.—Ed.)

Extracts from a Private Letter Relating to Garbage Disposal Works in Hamburg, Germany.

September, 1895.

Hamburg is to have garbage furnaces with 36 cells, or 900 sq. ft. of grate surface, which are to serve 300,000 inhabitants and to cost $125,000. The buildings are completed, but only one-sixth of the furnaces have been erected, because the details had not yet been fully determined upon. Six furnaces, each having 25 sq. ft. of grate surface, were placed and have been operated since the beginning of the year, namely, four Horsfall and two furnaces of local design.

The results so far are satisfactory, although an unexpectedly large amount of ash was obtained, namely, 60% of the original weight. Experiments are being made on the utilization of these ashes, to determine their value. From 5½ to 6 tons of garbage were burnt in 24 hours per 25 sq. ft. of grate surface, without the addition of any fuel whatever. The projected works are expected to do even better.

The remaining furnaces are to be constructed substantially according to the Horsfall design, with improvements suggested by the Hamburg authorities. Meantime it is proposed to make further experiments with the garbage of Hamburg and with that of other cities, so as to ascertain the best possible details in the method of destruction.

Extracts from Progress Reports and Letters by Messrs. Bohm (Government Councilior) and Grohn (Government Engineer) on Experiments with the Cremation of Garbage and Refuse in Berlin, Germany.

I.

September, 1895.

After a thorough examination of all methods in use in England and elsewhere, the sum of $25,000 was appropriated for the purpose of erecting several plants to experiment with the destruction of garbage and city refuse as collected in Berlin. The conclusions reached were that the furnaces of Horsfall and Warner, as used in England, accomplished the best results and that these should therefore be used in the experiments. As the results depended so much upon the proper operation of the furnaces, experienced engineers and firemen were sent to England to learn the practical details.

In November, of last year (1894—Ed.), the experiments were begun. It was soon discovered that it was not practicable to completely burn the garbage then collected, without the addition of some fuel. It was then tried to obtain better results by removing the fine ash by screening prior to introduction into the furnace. Although the results were much improved, it was still not found possible to completely burn the garbage of the winter and spring months without the addition of a small quantity of fuel.

To ascertain the necessary quantity and the best manner of applying the fuel, experiments demonstrated that a mixture of coal with the garbage to the extent of as much as 10% of its weight, would not yet give satisfactory results. Coke was then tried, because it would burn without smoke or soot and therefore reveal the character of the fumes resulting from the burning of the garbage itself. But as no fumes resulted therefrom, the experiments were continued with coal because it was less expensive.

An improvement was obtained by allowing the necessary coal to ignite near the furnace door and then spreading it over the refuse. In fact, this application proved to be very efficient when the refuse would not burn sufficiently well by itself.

The furnace was operated continuously day and night, as in England. An interruption and a cooling of the furnace was detrimental to good results.

For one month, in the spring, an English fireman, on leave of absence from the furnaces of the city of Leeds, was engaged to endeavor to improve the results and make them as good as those obtained in England. But he did not succeed well, because in Berlin the refuse contains less unburnt coal than in England.

A marked improvement was noticed with the advent of summer, due to the addition of more vegetable matter and less ashes.

In the Warner furnace, during one week in April, 25 sq. ft. of grate surface consumed 1.8 tons in 24 hours. The ashes remaining were 54.7% and the addition of coal was 1.68% of the original weight of the garbage. During one week in July, 25 sq. ft. of grate surface consumed 2.87 tons in 24 hours. The ashes remaining were 50.6% of the original weight of the garbage and no coal was added.

In the Horsfall furnace, during one week in April, 25 sq. ft. of grate surface consumed 3.55 tons in 24 hours. The ashes remaining were 49.7%, the coal added was 1.77%. During one week in July, 25 sq. ft. grate surface consumed 4.31 tons in 24 hours. The ashes remaining were 50.5%, and the addition of coal was 0.27% of the original weight of the garbage. Since July the refuse as delivered from the buildings can be completely burned without adding any fuel whatever. The Horsfall furnace requires a steam jet under the grate, using about six pounds of steam per hour per sq. ft. of grate surface, which requires a considerable quantity of coal not mentioned above.

In England, 25 sq. ft. of grate surface, or what is called "a cell," will burn from 6 to 7 tons of refuse in 24 hours. The ash remaining is about 33% of the original garbage and no fuel is usually added.

The temperature of the gases of combustion in the flue was measured continuously and in comparison with English furnaces was remarkably low in the winter, but was much higher in summer. Still, it was not found possible to use the furnace in Berlin at any time for the production of steam, as is done in many English cities.

The reason for this difference between English and German results is to be sought in the character of the refuse. In Germany, there is less waste of coal, less kitchen refuse and an excess of sand, fine ashes and other incombustible material.

To ascertain the precise character of the Berlin refuse in April, when it was deficient in combustible matter, and in August, when it was more easily burnt, mechanical analyses were made. About 40 tons of material were selected in each case, averaged from different parts of the city and days of the week, with the result shown by the accompanying table.

Mechanical Analysis of Berlin and English Garbage, in Per Cents.

	April.	August.	English Refuse.
Coal	0.13	0.21	0.15
Half-burnt coal or cinders	1.20	1.32	28.8
Paper	2.54	5.97	[1]
Rags	0.74	1.57	0.425
Bones	0.51	0.55	0.25
Wood	0.14	0.66	
Other organic matter	26.80	34.1	
Material removed by a coarse screen and containing much organic matter	2.13	1.97	14.20
Material removed by a fine screen	57.12	43.19	52.60
Clinkers	1.58	1.18	[2]
Glass	1.15	1.40	0.30
Iron	0.19	0.20	0.35
Broken crockery	5.01	7.19	2.90
Tin cans, etc	0.67	0.49	0.025
	100.00	100.00	100.00

[1]Not given; [2]not specially given.

The greatest difference between Berlin and English refuse is in the large quantity of half-burnt coal or cinders in England, and this explains the success of the cremation process there.

In Berlin the better results obtained with the burning of refuse in summer than in winter is explained by its containing a greater quantity of paper, rags, wood and kitchen garbage, and by the reduced quantity of fine material, consisting mostly of sand and ashes. This large quantity of fine material, containing still as much as 13% of combustible matter, has an unfavorable influence upon the creation of the refuse. If it can be removed by screening, the capacity is increased to 6 and even 8 tons per 25 sq. ft. of grate surface per 24 hours.

Besides the mechanical analysis the department also made chemical analysis. In November, for instance, the refuse contained 40% of water; in August it contained approximately 50%. The clinkers from the grate showed a complete removal of all volatile and organic matter. The ash which fell through the grate was from one-fourth to one-third of the weight of the original refuse, and contained from 7 to 14% of organic matter, which had fallen through the grate by raking before it was burnt.

Analysis of the gases of combustion show a great variation according to the condition of the fire. There is less carbonic acid and more carbonic oxide than in a furnace fired with coal. The combustion is therefore not as perfect.

Regarding the creation of any nuisance in the neighborhood, it may be said that the chimney gives out no dense smoke, but often fumes of a slightly yellow color containing some dust. But no discoloration of the snow-covered areas was noticed in winter, nor in summer upon sheets of white paper which were placed at various distances and in different directions from the furnace. Samples of the gases were collected in bottles placed in the flues. They had a whitish color and an odor resembling that of the gases from coal fires. Several examinations were made daily regarding the odors at neighboring premises. Five per cent. of the observations indicated a strong, and 8% a faint odor.

There were at first two, but now there are three shifts of firemen; one fireman attending to three cells.

II.

January, 1896.

The result of the first experiment (February to April) could not be pronounced a favorable one, as the efficiency of the furnaces was on the average but 2.79 tons per cell* per 24 hours, and as it was necessary to add fuel. Subsequent experiments have given a better result. The further they extended into the warm season, the more readily the garbage was consumed, and the less fuel was added. During June such an addition was only occasionally required. Between the middle of July and November, none whatever was necessary, and both furnaces (Horsfall and Warner) then consumed on the average about four tons of garbage per 24 hours per cell.

During interruptions (change of shifts and holidays) the mass of garbage generally remained in a glow, so that on resuming work it could easily be re-ignited. Even after the fire had ceased it was possible to re-ignite the garbage without the addition of fuel.

The rapid decline in the efficiency of the furnaces about the beginning of November is noteworthy. It was lowered to two-thirds and even to half of the summer efficiency. At the same time the quantity of ashes in the garbage increased and it was again found necessary to add fuel in order to maintain the fires. In one system this was necessary at the beginning of November and in the other at the middle of December. The cause of this decreased efficiency may be found in the fact that the weather began to get very cold about the end of October and buildings were generally heated, and therefore contributed ashes to the refuse.

A noticeable decline in the efficiency and an increase of ash had already been occasionally noticed in September and October. The reason for this lay in the fact that at this time there was a general repairing of stoves, and much clay, brick and tile was mixed with the garbage.

The experiments were conducted also with screened garbage, freed of fine ashes. The efficiency of the furnaces was hereby generally doubled and rose to the daily consumption of 8.4 and 9.5 tons per cell, while the percentage of ash materially decreased.

In September, by the advice of the Horsfall Company, their furnace was extended by the addition of a new cell, so that now each system consists of three cells.

The following particulars are noted regarding the experiments, which were repeated and continued substantially in the same manner as before reported: The examination of the fine particles which had fallen through the grate showed that they still contained unburnt organic matter, which was dropped from the fire too soon by shaking the grate. Therefore, it was tried for some time to accomplish the combustion without moving the grates. But during this experiment the efficiency was materially reduced, so that it was necessary to resume the shaking of the grate in order to reach acceptable results.

The experiments on the effect of the steam jet of the Horsfall furnace, which were conducted during June and July, in such a manner that alternately one cell was operated with and the other without the jet, demonstrated in a general way that an increase in the quantity of burnt matter was obtained by its use. But there is the disadvantage that, if the garbage does not burn well enough to sufficiently heat the whole furnace, the added steam is condensed and water runs down the sides of the furnace wetting the garbage and causing the moistened ash to close up the spaces between the grate bars.

In order to determine whether the introduction of vapor into the cells could be prevented and whether the steam jet, which forms an integral part of the Horsfall furnace, could without detriment to the combustion be replaced by another artificial method of introducing air, experiments were made in one cell with a blower which forced only air beneath the grate.

During September, forced draft with dry air increased the efficiency, which was 4 to 4½ tons, with the steam jet, to 6.3, 6.7 and even 7.9 tons with the blower. In this manner, the same results reached by furnaces in England were temporarily obtained. As the application of the blower gave such good results, two Horsfall cells and three Warner cells were thus equipped. The plant has therefore been improved, but a still further improvement in the blowers themselves is contemplated.

The temperatures measured in the flues indicated, as formerly, great variations, but in general they were much higher when the garbage was more thoroughly

*A cell has a grate area of about 25 sq. ft.

consumed, than at the time of our last report. While the blower was in operation, or when the garbage was screened the temperature rose to 400° C. (752° F.) and often still higher.

A mechanical analysis of the garbage was made in the spring with a quantity of 41,000 kilos. (90,200 lbs.), and another was made in July and August with a quantity of about 34,000 kilos. (74,800 lbs.), the assorting and screening being done in precisely the same manner as before. A comparison between the two analyses showed that the fine ash, which was 54% in the spring, was reduced to 43% in the summer, and the combustible matter (paper, rags, wood and other animal and vegetable matter) was increased from 33% in the spring to 44% in the summer.

With reference to any annoyance or nuisance resulting from the operation of the cremation process, it may be noted that the results reported previously have substantially been confirmed during the continuation of the experiments. The neighbors suffered no unpleasantness from the dumping and accumulation of the garbage around the works. Even during the hottest days of the summer no strong odors could be detected. There was also no annoyance caused by any dust escaping from the chimney.

As before, an odor from the escaping gases of combustion was repeatedly detected, not around the works, but at some distance from them. The complaints of a property-owner on the other side of the river caused a thorough inquiry on this subject to be made. At distances of 300 to 700 meters (925 to 2,275 ft.) around the works several stations were arranged for observation and repeated and special observations were made at greater distances in the direction of the wind. The result of 1,229 observations made between July and November showed that an odor of burnt matter was not perceptible in 949 cases (77%); it was slight in 207 cases (17%), and it was considerable in 75 cases (6%). When the gases of combustion rise, they are not offensive nearby or at great distances. The odor is only perceptible when the gases descend, and oftener during cloudy and damp weather than when the air is clear.

The solid products of combustion were somewhat less during the time when the efficiency of the furnaces was greater than last winter. No utilization of these products has been accomplished up to the present time, as but few requests have been made for them. Repeated advertisements in different papers resulted in the removal of 170 loads, about 10% of the available quantity. No profit has been realized; in fact, there was some cost to the city connected with the removal.

The force account is as follows: 2 foremen; 4 firemen; 2 stokers, and 9 laborers; total, 17. At the time of greater consumption, during about four months, when greater demands were made upon the firemen, they have worked in three shifts of eight hours each. Now they work again in two shifts, the same as the remaining force has always done.

From Jan. 4 to 9 (1896) garbage from Elberfeld was burnt in our furnaces. The result of this experiment was favorable. About 4 to 4½ tons per cell were burnt daily without the addition of fuel.

The experiments with the cremation of garbage and dry refuse, according to English methods, have shown the following results in our works and with our firemen:

(1) In the warm season the Berlin garbage and refuse, as it comes from the houses, burns without the addition of fuel and without previous sorting and screening.

(2) During the remaining seasons, particularly during the period when domestic furnaces and stoves are being used, it burns only with the addition of fuel.

(3) The screened garbage, that is, freed of its fine particles, burns in winter as well as in summer without the addition of fuel.

These results demonstrate that it is possible to cremate our garbage according to English methods. If it is not screened then the cost is increased at certain times by the necessity of adding fuel.

The principal reason for making these experiments is to be sought in the hygienic advantages which are to be expected from garbage cremation. Therefore, it was necessary to ascertain whether these advantages hold a reasonable relation to the necessary cost. For this purpose it is required that the cost of operating the furnaces a whole year be ascertained. This cannot as yet be done. The continued operation commenced February 8, 1895, but the results obtained in February and March should not be considered normal on account of the novelty of the work and the inexperience of the men. In order to get a complete and reliable basis for the pecuniary aspects of an eventual introduction of this method, it is necessary that the experiments should yet be continued for several months.

It appears surprising that other cities of the continent which have experimentally investigated the question of garbage cremation, should have reached better results than we. The cells in England burn 6 to 7 tons in 24 hours. In Paris an experimental furnace consisting of one cell is reported to have reached a similar efficiency. We are informed from Hamburg that their results with the burning of garbage have been entirely satisfactory, and that it was never necessary to add any fuel. The Hamburg plant, which formerly had six cells had been increased since the end of last year to 36 cells, and is intended to consume one-half of all the garbage of the city. It may be remarked, by the way, that this is at present the largest garbage cremation plant in the world. The burning of garbage obtained from the cities of Essen and Stuttgart, in the Hamburg furnaces, has been very satisfactory.

A comparison of the results obtained at our works, with those obtained in the furnaces at Hamburg and Paris, and also with the garbage from Essen and Stuttgart, shows much to our disadvantage. The reason for this relative failure may, according to our belief, be found in three different factors:

(1) In the composition of the Berlin garbage.

(2) In possible imperfections in our experimental plant.

(3) In the insufficient practice of our operating force.

Our own observations would indicate that the less satisfactory results which we have obtained are mainly due to the peculiarity of our garbage.

On the part of the Horsfall Co., whose engineers were repeatedly present during the experiments, it was explained that the relatively poor results reached by our experiments were possibly due to the loss of heat from the open position of our works, and also to the fact that our firemen were not sufficiently practised in operating the furnaces.

It must be acknowledged, with reference to the first point, that a complete enclosing of the furnaces by a building would have been more advantageous. But our observations and calculations have shown that the loss of heat is not so great that it would have had a material influence upon the result. In regard to the ability of the firemen, we believe we have a sufficiently instructed force of men, because most of them have worked at our furnaces for a long while. But it is not to be denied that the experience gained by several years' work would have a favorable influence.

While we, therefore, are of the opinion that these poor results are not due to any notable imperfection in our experimental station, or to an insufficient experience of our firemen, we nevertheless think it advisable to make further experiments in both these directions. It would first seem to be advisable to make an experiment by allowing our own winter garbage to be burnt in the Hamburg furnaces by their own men. This will demonstrate what results Berlin garbage gives at works which are more perfectly conducted. The Hamburg authorities have cheerfully consented to undertake this experiment. A further experiment would be to burn Hamburg garbage in our furnaces.

To ascertain the competency of our firemen, the Horsfall Co. proposes a comparison between them and experienced English firemen. Although last spring an English fireman was engaged at our furnaces, it was necessary as the burning was continued throughout the night, to alternate with our own men, which of course considerably affected the result of his work. A service consisting entirely of experienced English firemen would show what effect might be obtained in the future, under the most favorable conditions, when we would expect to have educated a corps of sufficiently skilful firemen.

Should it be found that Berlin garbage cannot be burnt with success in the Hamburg furnaces, and that essentially better results cannot be obtained by English firemen, then it would be demonstrated that our less satisfactory results are due solely to the composition of our garbage.

Such controlling experiments are extremely desirable in order to pass judgment upon the value of our experiments. In view of the fact that without doubt good results with the cremation of garbage will be obtained in other German cities, it is possible and even probable that sooner or later the opinion would form that the deficient results obtained by our experiments were due to imperfect arrangements at our works and to inexperienced men. And if this opinion spreads, it is likely that it will be demanded that these experiments be repeated, which would probably then require a much greater cost. We, therefore, consider their continuation at the present time to be necessary. The estimated cost thereof is 25,000 marks.

TRANSVERSE TESTS OF BEAMS OF OREGON PINE (DOUGLAS FIR).

We have received from Mr. William Hood, Chief Engineer of the Southern Pacific Co., a large roll of blue prints containing the results of transverse tests of 60 beams of Oregon pine, including plotted diagrams of the observations and drawings showing the position and other characteristics of the grain markings in each beam. We give below Mr. Hood's letter, together with a memorandum concerning the tests, and a table giving the summary of the results and figures of moduli of elasticity and fibre stress which Mr. Hood proposes for values to be used in designing structures. We trust that these results and Mr. Hood's proposed figures will receive attention from engineers interested in the subject of the strength of timber, but we would caution them that these figures are open to the criticism which was made by Prof. J. B. Johnson, in our issue of March 28, 1895, concerning earlier tests of Douglas fir, made at the Leland Stanford University, that is, that "no modulus of rupture can be received as indicative of relative strength, unless the percentage of moisture was obtained throughout the cross-section at the time of the test." A failure to observe this function, says Prof. Johnson, may cause the strength of the timber to vary by 100%. As shown by Mr. Hood's table, given below, the working figure for extreme fibre stress for single beams is 2,200 lbs. per sq. in. for beams 2 ins. square in section, and only 800 lbs. per sq. in. for beams 16 ins. square. This difference may be largely, if not entirely due to the fact that the 2-in. beams had been more perfectly deprived of their moisture than the 16-in. beams. The greater strength of the narrower beams of the same width, as found by Mr. Hood, may possibly be explained in the same way. Mr. Hood's letter is as follows:

The tests of timber, as conducted by the Forestry Division of the United States Department of Agriculture, so far as published in its Progress Report Bulletins, as well as tests made in various university laboratories and by individuals, have furnished valuable information, which when complete and systematically collated at some future time will no doubt give exceedingly useful data for the use of engineers.

It would appear that such tests would have a more direct practical value if an endeavor were made to test beams of sizes corresponding closely to the dimensions of beams used in ordinary construction, with a range of sections from the smallest to the largest in use.

Tests of transverse strength of beams have generally been made with small sections of test pieces; and at present the tests of beams of large sections are comparatively few and are not systematic. The results has been misleading to some extent to many engineers, as the difference in calculated strength and stiffness of different sizes of beams, especially of certain kinds of timber, has not always been fully appreciated.

I send you herewith a roll of blueprints with memoranda attached, illustrating some tests of the timber commercially known as Oregon pine, which, as you are aware, is extensively used on the Pacific coast for beams requiring transverse strength and stiffness. The number of beams tested was small, only 60, but with a fair range of dimensions. These prints and attached memoranda illustrate quite fully the value of tests of beams of various kinds of timber on the same general principles as we followed; and especially show the objectionable nature of the method of dimensioning parts of structures by the use of data obtained from tests of small beams.

The first and second sheets of the blueprints contain the essential results of our tests, the remaining large number of blueprint sheets making the record complete for any one wishing to follow out the tests minutely.

It will be noticed that I differ from many experimenters, including the U. S. Forestry Division, in the method of applying center weight increments in making tests, and do not follow the method of continuous increase of load, taking deflection readings at the instant the load becomes certain amounts, but allowing a 15-second time interval in all cases before reading deflections.

Should you desire to make use of the matter sent, it is entirely at your service to put into such form as may be expedient, this letter being written only to invite your attention to the subject.

I have made a few copies of the blueprints and memoranda for distribution to some of my professional friends who take an interest in such matters.

Memorandum Accompanying Tests of Oregon Pine (Douglas Fir).

Computations of outer fiber stress F, in pounds, made by the usual formula:

$$F = \frac{6 \text{ moment}}{B H^2}$$

which is the same as

$$F = \frac{3 W L}{2 B H^2}$$

with

W = center weight in pounds,
L = span in inches,
B = breadth in inches,
H = depth in inches.

Computations of modulus of elasticity E, in pounds, made by the usual formula:

$$E = \frac{W L^3}{48 D I}$$

which is the same as

$$E = \frac{W L^3}{4 D B H^3}$$

with

W = center weight in pounds,
L = span in inches,
B = breadth in inches,
H = depth in inches,
I = moment of inertia,
D = deflection in center, inches.

Computations of unit elongation in outer fiber U, made by the usual formula:

$$U = \frac{12\,C\,D}{L^2}$$

which is the same as

$$U = \frac{F}{E}$$

with
C = distance of outer fiber from neutral axis, inches.
D = deflection in center, inches.
L = span, inches.
F = stress in outer fiber at elastic limit, lbs. per sq. in.
E = modulus of elasticity, lbs. per sq. in.

Stress in whole section, considered concentrated at radius of gyration, is calculated in the usual manner and is always 1-1,732 or 0.577 of stress in outer fiber, for rectangular sections.

It would seem that for practical use of timber there should be the following data for each sort of timber in use, and that the data should be obtained from tests of the average quality of air-seasoned lumber, as obtained from lumber dealers, and corresponding as nearly as practicable to the quality of lumber with which a commercial order would be acceptably filled:

1. Direct tensile strength at elastic limit and at failure, with corresponding modulus of elasticity.

2. Direct compressive strength endwise with the fiber, at elastic limit and at failure, with corresponding modulus of elasticity.

3. Direct compressive strength across the fiber, at elastic limit and at failure, with corresponding modulus of elasticity.

4. Direct resistance to longitudinal shear, parallel to fiber.

5. Outer fiber stress of beams of all the dimensions, especially of all the depths used in practice, as computed by the ordinary formula from the applied center weights at the elastic limit and at failure.

6. Modulus of elasticity of beams of all dimensions, especially of all the depths used in practice, as computed by the ordinary formulas from the applied center weights and resulting deflections, within the elastic limit.

7. The determination of the elastic limit of beams, from the applied center weights and resulting deflections, the term "elastic limit" being used as signifying the yield point or point at which the applied weight and center deflection cease to bear a constant ratio to each other. The elastic limit being then the point at which the beam begins to break or receive permanent injury.

The functions of most value are the least and the average as obtained from timber tests. The least for use with single beams and the average for use where several beams act together. Of the above-mentioned data, items Nos. 1, 2, 3, 4, have been obtained for many varieties of timber with reasonable accuracy by many experimenters, except as to the special modulus of elasticity applicable to the several classes of strain. It is probable that such moduli of elasticity and also elastic limits pertaining to items Nos. 1, 2, 3, are difficult to obtain by experiments, but can probably be obtained by use of suitable apparatus.

To obtain the data above mentioned in items Nos. 5, 6, 7, for Oregon pine (Douglas fir) has been the object of the experiments and calculations illustrated by the attached blue prints. The results are supposed to be reliable for the beams tested, and subject to modification as the result of any farther experiments with corresponding sizes of timber that may hereafter be made. The proposed working functions seem more rational for use than functions obtained exclusively from tests of small sections of timber.

The proposed working modulus of elasticity, ranging for single beams from 950,000 lbs. for beams 16 ins. deep to 1,650,000 lbs. for beams 2 ins. deep; and for beams acting together from 1,070,000 lbs. for beams 16 ins. deep to 1,790,000 lbs. for beams 2 ins. deep may perhaps be changed, as the result of farther experiments, to moduli directly proportional to the depths of the beams. This direct proportion would, for instance, make the modulus for a single beam 9 ins. deep 1,300,000 lbs. instead of 1,130,000 lbs., as given on the blue print, and would make the modulus for beams 9 ins. deep acting together, 1,430,000 lbs. instead of 1,250,000 lbs., and so on for the other depths. With the present information, however, the moduli given on the blue print are the safer for use.

The special characteristic of the tests is the holding each center weight increment constant for 15 seconds before reading the corresponding center deflection.

This was done on the hypothesis that the adjustment of the fiber strains of the beam to the proper deflection requires an appreciable interval of time, and that the application of each weight increment produces at first some compression of the fibers of the beam at the bearing plates before the beam has deflected properly, which compression is relieved to some extent by allowing time for the beam to adjust itself to the proper deflection. If the deflection were measured at the instant of the application of the weight increment, such deflection would be too small by the amount of such compression at bearing plates and the resulting computed modulus of elasticity would be too great.

The difference in computed fiber stress between small and large beams has been often observed, particularly in varieties of fir, but does not seem to have been systematically experimented on with such varying depths of beams as are used in ordinary practice.

The results obtained show that although Oregon pine beams of sundry depths have the same actual fiber strength regardless of depth of beam, they must be treated as if having very different fiber strength and stiffness, per depth of beam used, when stresses are computed by the ordinary formulas in use for computing beam stresses, etc. This characteristic is perhaps more pronounced for varieties of fir than for other timber, but it seems probable that suitable experiments may show it to exist more or less in all varieties of timber and possibly that it exists to a more or less degree, sometimes scarcely appreciable, in beams of rectangular section of any material which has direct tensile strength in excess of direct compressive strength.

Experiments are needed to show the effect of loads applied for a considerable time to timber, like 30 days, for instance, using for the experiments many specimens of each size of beam used in practice. To properly carry out such experiments would require ample space and time, to an extent probably beyond the resources of individual experimenters.

William Hood.

San Francisco, Cal., March 25, 1896.

TESTS OF OREGON PINE BEAMS AT SOUTHERN PACIFIC COMPANY'S SHOPS, SACRAMENTO, CAL. NOVEMBER AND DECEMBER, 1895.

Center load increments held constant for 15 seconds before measuring corresponding center deflections.

Deflections measured by fine single thread and mirror scale and reading glass. Computations made by the usual formulas, assuming plane of neutral axis at one-half the depth of the beam. Work with testing machine by Howard Stillman, Engineer of Tests, S. P. Co. Computations in office of Chief Engineer, S. P. Co.

The beams tested were rough commercial Oregon pine (Douglas fir) from region of Puget Sound, well air seasoned in Oakland, Cal., and fairly represent good average quality of lumber, such as would be obtained of any reliable firm to fill an order for such lumber.

In general, in beams of same depth and same general seasoning, the beams of greatest specific gravity seem to have the greatest ultimate strength. In beams of same depth and differing widths, the narrower beams seem the stronger. This may be in part due to the narrower beams being likely to have less knots and season checks, al o perhaps to the skin of a seasoned beam being slightly harder and stronger than the interior, and the narrower the beam, the larger the proportion of such hardened skin.

The beams of small depth show excess of calculated strength over the beams of larger depth, chiefly from the use of formulas assuming plane of neutral axis at half the depth, which is the nearer true the less the depth of the beam; and partly from the small depth beams being in fact better material in general than larger depth beams. That is, knots and defects that would cause the rejection of a beam of very small section, would be allowed in a beam of large section.

The term "elastic limit" is used to express what may be termed the "yield point" or point at which the applied weight and center deflection cease to bear a constant ratio to each other. That is, the point at which the beam begins to break, or receive permanent injury.

In the last four columns of the summary shown below, are proposed working functions which are considered better to use until further information may be obtained, than to follow the common practice of using functions obtained from tests of small sections of beams, and taking an arbitrary per cent thereof for working functions for any and all depths of beams.

Summary of functions calculated from tests.

Av. depth beams, ins.	Modulus of elasticity E, lbs. per sq. in. Least.	Greatest.	Average.	Outer fiber stress at elastic limit, lbs. per sq. in. Least	Greatest.	Av'age.	Outer fiber stress at failure, lbs. per sq. in. Least.	Greatest.	Average.	Ratio.*
1.978	1,651,155	2,159,738	1,793,761	6,600	7,282	6,953	10,574	12,677	11,215	0.62
2.932	1,168,366	1,618,438	1,473,334	4,489	8,415	5,887	9,887	12,538	11,358	0.52
3.932	1,330,841	1,871,446	1,620,333	6,040	7,251	6,818	10,193	13,145	11,678	0.58
....	.....	.....	.....	....	....	....	....	....	....	....
5.995	1,443,880	1,814,433	1,590,239	5,675	8,127	6,467	10,840	11,715	11,205	0.58
6.955	1,677,670	1,867,363	1,784,945	4,076	5,340	4,859	7,486	10,049	8,294	0.59
8.040	1,347,448	1,860,960	1,642,521	3,890	4,986	4,560	7,616	9,912	8,575	0.53
....	.....	.....	.....	....	....	....	....	....	....	....
10.060	1,281,107	1,435,930	1,356,035	3,123	4,120	3,679	5,477	7,782	6,856	0.54
....	.....	.....	.....	....	....	....	....	....	....	....
11.908	1,105,217	1,496,196	1,347,364	3,617	4,772	3,937	5,406	6,824	6,198	0.64
....	.....	.....	.....	...	...	...	....	....	....	....
....	.....	.....	.....	...	...	...	....	....	....	....
....	.....	.....	.....	...	...	...	....	....	....	....
16.036	950,046	1,181,250	1,074,334	2,446	5,673	3,709	4,104	6,961	5,502	0.67

*Ratio of average outer fiber stress at elastic limit to average outer fiber stress at failure.

It will be seen that the outer fiber stress at elastic limit ranges from one-half to two-thirds the outer fiber stress at failure.

Working to one-third outer fiber stress at elastic limit, will give results 1-6th to 1-4.5th the breaking outer fiber stress.

Working to one-half outer fiber stress at elastic limit will give results ¼ to ⅕ the breaking outer fiber stress, and so on.

Proposed funct'ns not to be exc'ded in struct're.

Modulus of elasticity E, lbs. per sq. in. Single beams.	Beams act-ing together.	½ outer fiber stress at elastic limit, lbs. per sq. in. Single Bms actg beams, together.	Depth.
1,650,000	1,790,000	2,200	2,300	2 ins.
1,550,000	1,690,000	2,000	2,150	3 "
1,460,000	1,600,000	1,850	2,000	4 "
1,380,000	1,510,000	1,650	1,900	5 "
1,310,000	1,440,000	1,500	1,800	6 "
1,240,000	1,370,000	1,400	1,650	7 "
1,180,000	1,310,000	1,250	1,600	8 "
1,130,000	1,250,000	1,150	1,500	9 "
1,080,000	1,200,000	1,050	1,450	10 "
1,040,000	1,160,000	1,000	1,350	11 "
1,010,000	1,130,000	900	1,300	12 "
980,000	1,100,000	850	1,300	13 "
960,000	1,080,000	850	1,250	14 "
950,000	1,070,000	800	1,250	15 "
950,000	1,070,000	800	1,250	16 "

Should it be desired to use ½ outer fiber stress at elastic limit, add one-half to above figures for outer fiber stresses; for 16 ins., for instance, becoming 1,200 and 1,875 respectively.

THE CONSTRUCTION OF A GRAVEL ROAD.

A gravel road is to be built from Hammonton to Absecon, N. J., a distance of about 22 miles, and from the specifications prepared by Mr. J. J. Albertson, the engineer, we take the following particulars of the construction:

The roadbed will be cleared to a width of 30 ft., or between curb lines, and formed to a cross-section having a fall of 1 in 12 from the center to the sides. In the middle will be the gravel roadway, 14 ft. wide, with an earth shoulder 8 ft. wide on either side. Underdraining is to be provided for where necessary by means of 4-in. sole drain tile, laid on yellow pine boards, 1 x 6 ins., the tile having the joints covered with hay, and being laid so that its top is at least 30 ins. below the road surface. The tile trenches are to be filled with pervious earth. The gravel is to be placed upon the roadbed in one layer, then thoroughly harrowed and rolled, the thickness of the layer being such as to give a finished thickness of 8 ins. at the center, sloping gradually to a thickness of 6 ins. at the edges, or 7 ft. on each side of the center. The supervisor may, at his discretion, stop the work when the weather is such that the work cannot be properly done. The estimate of cost, as prepared by the engineer, is $1,250 per mile.

ANNUAL CONVENTION OF THE RAILWAY MASTER MECHANICS' ASSOCIATION.

The 29th annual convention of this association was held this week at Saratoga Springs, following immediately after the sessions of the Car Builder's Association. The first session on Monday morning was opened with prayer and an address of welcome by the President of the village of Saratoga. President R. H. Blackall then addressed the members. Among the important advances in practice during the year he noted the adoption of the tonnage rating for locomotives, and improvements in locomotive counterbalancing and reduction of the weight of reciprocating parts. He called attention to the importance in securing economy of obtaining improved forces of employes as well as improved machinery. He commended the work of the railway clubs and the improvement in their proceedings during the year.

The Secretary's report showed a total membership of 683, a net increase of 83 over one year ago. The Secretary announced that he would not be a candidate for re-election, and briefly reviewed the remarkable increase in the prosperity of the association during the nine years of his service as secretary. The treasurer's report showed a balance of $813 in the treasury after paying all the expenses of the year.

The amendment to the constitution, of which notice was given one year ago, placing the choice of the secretary in the hands of the executive committee of the association, was brought up and at once became the subject of an animated and at times rather personal debate.

The vote upon it, which was finally taken, however, showed that the sentiment in favor of the change was practically universal, the vote standing 89 to 6.

Last year the association adopted a standard gage for plate and sheet metals and wire, and the work of making such gages was undertaken by the Pratt & Whitney Co. A letter was read stating that the manufacture of the first lot of these gages was now nearly completed. Delay had been caused by difficulty in cutting the 1-2,000th-in. slot in the gage; but this had finally been accomplished and the gages, of which 500 have already been ordered, will be ready for shipment in about three weeks.

Mr. A. E. Mitchell (Erie R. R.) read an editorial note in the last issue of Engineering News, calling attention to the deliverance of the New York Railroad Commission, on the subject of radial stay locomotive boilers. It was voted that the subject be made a special order for discussion at noon on Tuesday, and that the New York Railroad Commission be invited to attend.

Mr. Higgins (Lehigh Valley) offered a resolution instructing the executive committee to notify Congress of the opposition of the association to the bill proposing compulsory use of the metric system, and it was adopted with only one or two votes in opposition.

A communication was received from the Master Blacksmiths' Association asking the approval of the Master Mechanics and their co-operation in securing the attendance of the blacksmiths at their convention. A resolution of approval was passed.

The Schenectady Locomotive Works invited the members to visit their works during the convention, and the invitation was accepted.

The Stevens Scholarship was the next subject brought up. A dozen years or more ago, at an annual convention in Boston, a large sum was collected for the entertainment of the Master Mechanics and a good part was unused. This was kept for some years, until it had increased to some $5,000. An arrangement was then made with the trustees of Stevens Institute to found five free scholarships in that school in consideration of the gift of this money to that institution, these scholarships to be for the benefit of such persons as the association might nominate. The association decided to offer these to the sons of its members, but ruled that at least a year's apprenticeship must have been served by the candidate after finishing school. This last clause has practically prevented the use of the scholarships, as a youth in order to pass Stevens' very strict entrance examinations needs to be fresh from school, and is pretty sure to fail if he has grown rusty by a year in the shop. A committee was appointed to take up this matter and report some method by which these scholarships can be made available.

Next came the reading of reports of committees, and the time-honored custom of reading in full a report already in print and in the hands of the members was abolished. Instead, the important points of each report only were presented.

Exhaust Pipes and Steam Passages.

This is a topic which has been prominently before the association for some time, and last year a very able committee, Messrs. Robert Quayle, Wm. Forsyth, Jas. McNaughton, W. S. Morris, D. L. Barne and W. F. M. Goss was appointed to make experiments. As the report presented covers 86 pages, besides a large number of drawings, space forbids even an abstract here. Our readers interested in the subject matter of the report will do well to secure a copy from the Secretary of the association, as it is a treatise on the subject giving information acquired at first hand and not to be found elsewhere. Some of the conclusions reached, however, have recently been set forth in these columns in an abstract of a paper by a member of the committee read before the Western Railway Club on the form of the exhaust jet.

We may remark that the committee favors what is commonly known as the "choke stack," which is designed with an easy entrance at the base and with the top flaring to a diameter about 3 ins. greater than that at the choke or narrowest point.

As the report was so voluminous, the discussion was practically confined to questions looking to the elucidation of various points in connection with it. The committee was finally instructed to secure the introduction in service upon various railways of stacks designed in accordance with the principles laid down in its report, and report the results obtained next year.

Counterbalancing Locomotives.

This report was on a subject which has been exhaustively treated at different times; but its importance is such that we shall present the report in full in our next issue. The discussion upon it, while extended and interesting, really brought out nothing additional to the matter contained in the report.

Balanced Valves and the Allen Valve.

This committee, of which Mr. Geo. R. Henderson, M. Am. Soc. M. E., of the Norfolk & Western, was chairman, was given two problems to solve: (1) to compare different types of balanced valves with plain valves, and (2) to determine the advantage, if any, of the Allen valve over the plain valve. The committee decided to send out circulars to obtain information as to current practice on each of these matters and also, through the courtesy of Purdue University and the aid of Prof. Goss, was able to make some actual comparative tests of the questions before it.

With respect to balanced valves, the committee's circular of inquiry revealed the fact that no two roads agreed in the percentage of valve area which was balanced. They varied all the way from 48 to 95%, though most of them were between 55% and 65%. The wear of seats and valves reported was from 1-32 to 1-16-in. per 100,000 miles on balanced valves, and twice to three times as much for plain valves, while the wear on the link motion varied in about the same ratio. All the responses strongly favored balanced valves, and with one exception all the users of piston valves approved them also.

The committee found that all the balanced valves on the market were of two types, those with a rectangular balanced area enclosed by straight packing strips, and those with a circular balanced area. The Richardson valve was taken as representing the former type, and the American valve, the latter, and tests were made with these valves and with plain valves on the locomotive at Purdue University.

As a result of all its extended tests the committee decided that the balanced valve requires on the average twice as much work to move it as the plain valve, and recommended the following rule for finding the area to be used in balancing: Area of balance = area of exhaust port + area of the two bridges + the area of one steam port. This rule is to apply to either Allen or plain valves.

Concerning the Allen valve, the majority of the replies showed that the Allen valve was satisfactory and especially advantageous at high speeds and short cut-offs. In some cases an engine with an Allen valve was given one or two more cars than an engine with a plain valve. The tests made by the committee showed very plainly the advantage of the Allen valve, in nearly doubling the speed of opening and closing the valve, which, of course, at high speeds or short cut-offs greatly lessens the throttling of the steam in the ports. From a large number of indicator diagrams taken in the comparative tests, the committee concluded that the Allen valve increases the average mean effective pressure in the cylinder about 20%. This, of course, means a great increase in the power of the engine. Whether a gain in economy was also possible, by cutting off shorter with the Allen valve, the committee did not attempt to determine. While longer ports or greater valve travel may give as much increase of port opening as the Allen valve, or a greater speed or longer stroke, they mean more power expended to move it and increased wear on seat and valve motion.

A long discussion ensued on this report and many members were inclined to question the conclusions of the committee. Nothing was presented, however, sufficient to upset the principles which the committee laid down, and which are stated above. The Allen valve is a very old invention. The patent upon it expired over a score of years ago, and the reason it is not in more extensive use is probably not lack of merit but the fact that because of the expiration of the patent, no one has any interest in pushing it into use. This concluded the first day's session.

At the opening of the session, on Tuesday morning, Mr. Geo. L. Fowler, M. Am. Soc. M. E., was elected an associate member and the application of Mr. E. F. Moore, Mechanical Engineer of the Michigan Railroad Commission, was received and referred to a committee for report.

Reciprocating Parts.

A great deal has been done in the past year or two toward reducing the weight of reciprocating parts, especially on locomotives designed for high speeds. It will be remembered that the "hammer-blow" of a locomotive is due entirely to that part of the counter-balance weight which is applied to balance the fore and aft motion of the reciprocating parts. Hence every reduction in weight of reciprocating parts means a reduction in the amount of the "hammer-blow," and consequent easier riding locomotives and trains, and less danger of injury to track.

The committee took it for granted that the benefits of reduction in weight of reciprocating parts were appreciated, and devoted itself to illustrating recent designs of pistons, cross heads, rods, etc., made with an especial view to reducing weights. We postpone the publication of this report to our next issue.

Cylinder Bushings.

This committee, through Mr. J. N. Barr, presented a strong report favoring the practice of bushing cylinders and also of applying false valve seats, and this not only to worn, soft or cracked cylinders, or to cylinders designed too large for the weight of the engine, but to new cylinders. The reason for this is that in casting cylinders the foundryman is between the devil and the deep sea. If he makes a soft, tough iron, which will give proper strength in the cylinder castings and saddles, he will have cylinders and valve seats too soft to take a polish and wear well. If on the other hand he makes cylinders of a hard iron, which will give good wear on cylinders and valves, he is liable to trouble with cracked cylinders and saddles. It appeared also that whereas the small cylinders of the old time engines, using low steam pressures, gave comparatively little trouble from cracking and the cylinder and valve seat wore well, with the larger cylinders and higher steam pressures now common, troubles have become frequent in both these matters. It appeared, therefore, that while the practice of bushing new cylinders is as yet practiced by only one or two roads, it is likely to become common in future, especially on locomotives with very large cylinders, or very high steam pressures and on compounds.

Hub Liners.

The committee on this subject made an extended inquiry concerning the practice of using liners between the hubs of locomotive driving and truck wheels and the boxes. Its conclusions were as follows:

1. That if a good system of interchange hub liners is in use it is unnecessary to make use of box liners.
2. That cast iron is sufficiently good material for hub liners, and that the use of brass or bronze is unnecessary.
3. That the application of hub liners to all the wheels of new engines, and to all wheels introduced under old engines, is good practice.
4. That the use of loose liners, riding on axle between wheel hub and box, is not good practice.

A long discussion followed, developing great diversity of practice and ideas. The practice of using a tin or babbit metal lining, however, appeared to be in very extensive use, and to give excellent results.

Steam Pipe Joints.

The conclusions embodied in this committee's report were as follows:

Steam pipes should be of cast iron of flattened section, as light in the body as consistent with strength and the requirements of foundry practice.

Your committee suggest, as worthy of trial, pipes of malleable iron or cast steel. Such pipes may be quite thin and still have ample strength, with the resulting advantage of springing instead of working at the joints when expansion strains are brought upon them.

The flanges should be arranged, where possible, to take four bolts or studs at both ends on all heavy engines. These bolts should be equally spaced, if possible. The joints should, in all cases, be made up with plano-convex brass joint-rings, the radii of their convex faces to be about equal to the inside diameters of the rings. These rings should be carefully ground upon their corresponding joint surfaces.

The exhaust pipe joints should be made with flat surfaces, carefully scraped and fitted with surface plate, and bolted together without copper or other gaskets. A small amount of red lead, or some kind of heat-hardening cement may be used if preferred.

The discussion on this subject brought out the interesting fact that many roads had been substituting cast iron in place of brass for the rings making up the flexible joint in the smoke-box with excellent results. Mr. Brown (D., L. & W.) has used them for 15 years. Mr. McConnell (Union Pacific) is experimenting with pipes of malleable iron. He has had a pipe made of this material only 7-16-in. thick and weighing only 180 lbs., against 273 lbs. for the cast-iron pipe. It cost only a dollar more, the figures being $4.13 for the cast iron and $5.16 for the malleable iron. The great advantage is that the pipe is thin enough to bend under expansion strains, and this does not move the joint.

The Safety of Radial Stay Boilers.

The discussion of the safety of radial stay boilers, aroused by the editorial note in our last issue respecting the remarks of the New York Railroad Commission concerning them, was then begun. Commissioner Ricker was present and repeated his statement quoted in our last issue that in explosions of boilers of the radial type the complete destruction of the boiler had resulted, which had not been the case with the crown-bar boilers. The members present then gave their experience with the two types of boilers, and all agreed that the radial stay boiler was as safe at least as the crown-bar type, and many members related experiences indicating that it was safer. The fact developed also that the explosions of radial stay boilers, which the railroad commission had examined, had in every case been of boilers of the Wooten type. This being the case, his testimony should be taken as relating to that style of boiler only and not as affecting the reputation of what is commonly known as the radial stay boiler. At the close of the discussion the following resolution was adopted unanimously by a rising vote:

Resolved, That it is the sense of this association that the radial stay boiler is as safe as the crown-bar boiler, and that the former is easier to keep clean and more economical in repairs.

This concluded the business of Tuesday's session. In the afternoon the members visited the Schenectady Locomotive Works, by invitation of its president, transportation being furnished through the courtesy of the Delaware & Hudson R. R.

The proceedings on the concluding day, Wednesday, we postpone to our next issue.

THE ANNUAL CONVENTION OF THE MASTER CAR BUILDERS' ASSOCIATION.

The 30th annual convention of the Master Car Builders' Association was held in Saratoga last week. The first session, on Wednesday morning, June 17, was opened with prayer by Rev. Dr. Corey, of Saratoga, and an address of welcome by Mr. Chas. H. Sturges, President of the Village of Saratoga. Col. H. S. Haines, late President of the American Railway Association, who was present by special invitation, then addressed the members, and we print the following extracts from his remarks:

Your association shares with the Master Mechanics' Association the distinction of being the pioneers in organizing the technical staff of the railways of this country for the interchange of information, and the success which has attended your efforts has incited officials in other departments to organize for similar purposes. The conclusions which your association has reached as to certain details of freight car construction have not only been accepted by the American Railway Association, but have been embodied by Congress in the Railway Safety Appliance Act.

As our minds revert to the past, how vividly we recall the low-roofed cabooses, which once served as passenger cars for the same class of travel that now obtains the most luxurious accommodation. For cabooses they were, indeed, with but scanty provision for comfort; but whether for day or for night travel, that was all that was afforded to the passenger, who marched from a train of such cars as weary and dirty as any tramp you may now meet along the highway. In due course the passenger car became less and less like a box car. It was lengthened and heightened; the deck roof improved its ventila

tion and its appearance. Conveniences of different kinds were added, but the great step forward was taken when provision was made for sleeping in a recumbent position while traveling. The traveler of to-day may well be grateful to Mr. Pullman for the manner in which this idea has been developed by him and by his imitators. But the man who first recognized the claim of a human being to stretch out his cramped-up limbs in a railway train, even though it was only on a hard plank, was the Columbus that discovered the sleeping car; and if he be unknown at present, the Master Car Builders' Association ought to appoint a committee to discover him.

The appliances for safety have kept pace with the appliances for comfort. One of the earliest which occurs to my mind was the sealing of the under side of floor joists, an improvement very forcibly impressed upon the minds of any one who ever participated in a derailment of an old time passenger car, when the car-body was snatched from the trucks and skidded along the rails, carrying out the floor joists as it went.

Think, too, of the advance, from the hand brake applied to a single truck up to the quick-acting brake of to-day; a step in the march of improvement with which the name of Westinghouse is inseparably associated, as is the name of Pullman with the development of the sleeping car.

It is the work of a master car builder which mostly impresses the traveler by rail. Little does he know or care about the labor and thought which have been expended upon the roadbed over which he luxuriously runs, or of the bridges and tunnels, masterpieces of engineering, which bear him, almost in the twinkling of an eye, across mighty rivers or through the bowels of lofty mountains. As he lolls in his chair of ease he may bestow a passing glance upon one of those huge Titans of steel, devouring coal and scattering smoke from its entrails as it speeds along its way. But he is unconscious of the ever watchful care of the train dispatcher and signalman; for his safety concerns him less than that he shall be commodiously entertained as he journeys along.

With these demands the master car builder has complied with such earnestness that the American traveling public is housed as princes never were before. They must have not only cushioned seats, comfortable beds, and toilet accommodations, with hot and cold water always turned on, but dining-halls as well, and observation cars, libraries and bath-rooms. A barber shop, and even a typewriter must be at hand. To what greater length are you master car builders going in your efforts to pamper and spoil the American people?

In the contest between the standard gage and the narrow gage track, in which we were all intensely interested some 20 years ago, the promoters of the narrow gage idea were never tired of expatiating upon the advantage which it offered, of a greater weight of paying freight in proportion to the weight of the equipment. It is true that they also claimed a saving in the cost of railway construction, but that was their principal argument, that the cost of transportation per ton per mile would be greatly lessened on the narrow gage roads, by reason of this reduction in dead weight, and they thus induced a useless expenditure of millions of dollars on thousands of miles of narrow gage roads, nearly all of which have since been changed to standard gage. Why have they been changed? Mostly because the master car builders have been steadily reducing the proportion of dead weight to load on the standard gage until now they have produced a car which will carry 60,000 lbs. or more of paying freight on less than 30,000 lbs. of dead weight.

Have you ever reflected upon the effect which the use of the four-wheel truck on American railways has had upon the social life of our people? Any one of you who has traveled on an English railway train must have felt the difference in being caged in a compartment with six or eight persons, and not having the free run, as in one of our trains, from the smoker to the observation car. Now, this difference is fundamentally due to the evolution of an English railway carriage from a stage coach. In fact, it is not so much the evolution from a stage coach as it is the fastening of stage coaches together, back to back. In thus keeping the carriages separate, the company has been separated also, the sheep from the goats, and the classification, originating in days when there was a strong social reason for it, in the days when the gentry traveled in their own carriages, business people traveled in stage coaches and the common people traveled in wagons, has been maintained on the English railways, long after the social reasons for it have been greatly lessened. Now, if the bogie or four-wheel truck had been adopted in England in their railway equipment, we should doubtless have seen somewhat the same results there as we have in this country; that is, long cars, with no side doors, and communication through the entire train. Hence, we have people moving from car to car, and seeing who is on board, and finding their friends, making acquaintances, and maintaining a general circulation of ideas and information, which assists in keeping the whole train load of passengers, of all sorts and kinds, from stagnating and separating into strata or different social elements. In the same way the train conductor has been brought into social contact with his passengers, and has thereby become an official to whom they look for direction and advice instead of a guard to be tipped with a sixpence. And this use of the pivoted truck has made it easier for us to provide sleeping berths and toilet accommodations,and dining cars and other conveniences which cannot be so readily provided on equipment built on English lines of practice.

In your action with reference to freight car couplers, your association laboriously and thoughtfully arrived at a type best suited for this purpose, and still left the field free for inventors to devise any kind of coupler which would conform to this type, to certain contour lines and other conditions essential to interchangeability among their several devices. The way was thus made clear for the introduction of many different couplers, each having its particular merit, and yet all interchanging. But for this action by your association there would have been a contest for recognition among different types of couplers, incapable of coupling with each other, sustained by powerful and interested advocates, and we should probably have seen a war of the couplers, as we saw a war of the gages, and with great exposure, and long continued, on the part of railway employes, to accidents. Therefore your action in compelling such uniformity, has not been a benefit to the railway companies alone, but the air brake and the vestibule platform coupling automatically, have almost eliminated the possibility of a fatal injury to a passenger from butting collisions. With the general adoption of the master car builders' type of freight car couplers, switching will cease to be a hazardous occupation, and the general application of air brakes to freight trains will, it is to be hoped, bring down the brakeman from the top of the cars and free him from exposure to the weather greater than the storm-tossed sailor suffers, and reduce the accidents incident to low bridges and tunnels. It is because these several safety appliances have been made uniform in their action that we are about to receive the full benefit of their application to the million or more cars that are now used in going from the Atlantic to the Pacific and from the Great Lakes to the Gulf of Mexico. Now, these great advantages to the public and the railway employes could never have been enjoyed but for the mutual action of the railway companies in this country, made practicable by your association, which is thereby becoming a public benefactor as well as a valuable auxiliary to the railway companies which you represent.

The President of the Association, J. S. Lentz, of the Lehigh Valley R. R., then delivered the annual address. He explained the work done by the executive committee of the association in securing from the Interstate Commerce Commission an extension of the legal limit of time for equipping trains with the hand-holds and appliances for the safety of trainmen required by the Safety Appliance law, and in securing the adoption of standards for the application of these. He also called attention to the standard sizes for trade catalogues, circulars, etc., adopted by the association, and urged that manufacturers observe them. He favored the adoption of a standard car of 80,000 lbs. capacity.

The Secretary's report showed a total membership as follows: Active, 228; representative, 155; associate, 5; total, 388, an increase of 16 members. The number of cars represented in the association to date is 1,209,291, an increase of 57,334 cars during the year. The association's receipts during the year were $8,979, and its expenses were $7,370. The balance with the cash on hand at the beginning of the year makes a total of $5,509 now in the hands of the treasurer of the association.

Next followed the appointment of various committees for the routine business of the association, together with one to report on standard rules for the loading of long timbers, 60-ft. rails, etc. A resolution was adopted requesting Congress to make further appropriations for carrying on the timber tests which the Forestry Department has undertaken.

The reports of standing committees were then taken up. Mr. Rhodes (C. B. & Q. Ry.), for the Committee on Triple Valve Tests, reported that no valves had been submitted for test during the year, and so no report was necessary. Mr. Barr (C. M. & St. P. Ry.), for the Committee on Standard Wheel and Track Gages, also reported that the committee had nothing to present. The convention therefore took up the discussion of topical questions as follows:

(1) Tests for Air Hose.—Is it possible to approximate a service test in a short time, and to get an idea of the relative durability and value of different makes?

Mr. Barr had been using a hose testing device which subjected hose to repeated bending, and he had reached the conclusion that it was better to make hose pliable than to make it strong and heavy enough to stand 600 to 700 lbs. air pressure. He thought a cheap cotton-covered hose was likely to give as good results as the expensive high-pressure and stiff hose, which had been generally used of late. The 1-in. hose stood two or three times the amount of bending that 1¼-in. hose did. Mr. Schroyer suggested that the quality of the rubber had very much to do with the quality of the hose.

(2.) What are the comparative advantages and disadvantages in pressed steel and diamond types of trucks?

Mr. S. Higgins (Lehigh Valley) said that there are now about 90,000 pressed steel trucks in service, most of them under cars of 60,000 lbs. capacity. Their advantages are as follows: (1) A decrease of weight from nothing to 2,000 lbs. per car, as compared with a standard diamond truck. (2) Saving in repairs.—On one road with several thousand cars on pressed steel trucks a record was kept for a year and the repairs on the pressed steel trucks were found to be only one-tenth the cost of the repairs on the same number of diamond trucks, which, however, had been running three years to the pressed steel trucks one year. (3) The pressed steel truck is not so likely to get out of square, hence we secure long life of wheel flanges, easier pulling trains and less liability to have hot journals. It is stated that on one of the largest roads in this country two cars more per train can be hauled with cars on pressed steel trucks. As showing that cars on these trucks ride better, it is found that the trainmen select them to ride on when not in the caboose.

The advantages claimed for the diamond truck are its smaller first cost; that it is easier to repair after wreck or derailment, and that it is easier to inspect the outer face of wheels, and that it is easier to change wheels. Mr. Higgins finds, however, that the saving in cost of repairs due to pressed steel trucks amounts to 4% on its increased cost. The greater facility of repair to diamond trucks is offset by the fact that pressed steel trucks are less damaged in accidents. He also believed that it was really no more trouble to change wheels under pressed steel trucks than under diamond trucks.

Mr. Sanderson (Norfolk & Western) had tried pressed steel trucks but had not found them as successful as a well-designed diamond truck. It is unfair to compare the pressed steel trucks with older weak designs of diamond trucks. Mr. Rhodes urged that in designing all-metal trucks of any type special attention should be paid to reducing the weight and decreasing the number of parts.

(3.) Break-in-twos in trains between cars equipped with M. C. B. type of coupler. To what extent do they occur? What are their causes, and how can they be prevented?

This gave rise to one of the most extended and valuable discussions of the convention. Mr. Waitt (L. S. & M. S. Ry.) said that the record had been kept for the first five months of 1896 on the Lake Shore & Michigan Southern Ry., of all break-in-twos of trains from any cause whatsoever, either on the road or in yards, and the total number was 467. Of this number 45% occurred between cars that were coupled with the link and pin, caused by the coupling pin breaking, or working out, or the link breaking; 26½% occurred from the knuckle in the M. C. B. coupler opening in some way; and 21% occurred on account of the drawbars pulling out, on account of the spindle breaking, or the drawbar key breaking, or the key dropping out. The balance, 7½%, were due to miscellaneous causes. Mr. Waitt estimated that about 35% of the cars moving over his road have M. C. B. couplers.

There being such a large number of cases on account of the knuckles opening, 26½%, it was endeavored to ascertain the cause, and the large majority seemed to be on account of improper adjustment or attachment of the uncoupling mechanism, coming in most cases from the chain connection between the uncoupling lever and the lock or pin being so short that with compression or extension of the draft spring the chain is drawn taut and the lock is lifted enough so that the uncoupling takes place.

Mr. Day, of the Atlantic Coast Line, said that with the old style lock on the Janney coupler he had no trouble; with the new lock, however, the pins would work up. Mr. Sanderson, on the Norfolk & Western, had so much trouble with the couplers on the rear of passenger tenders that he was obliged to insert springs to hold the locking pin down and prevent it from jumping up and releasing the knuckle. Mr. Barr said that on his lines the break-in-twos from unlocking of M. C. B. knuckles are four times as numerous as those from link-and-pin couplers. Mr. Lewis (Chicago, Burlington & Northern) said that the locking pin would creep up by jar and nipping of the pin, very much as a pin will sometimes creep up in a link-and-pin drawhead. Other members described a style of coupler used on some gondola cars which carry slack coal in which the coal collects under the locking pin and prevents it dropping into place. Still another thought that a round link chain should be used for uncoupling, as with the common cable links a link may be turned so as shorten the chain. It was the general sentiment that makers of M. C. B. couplers should adopt some means for holding the locking pin positively down when the knuckle is closed, and that care should be given to allow ample slack in uncoupling chains.

(4.) Protective Paint for Metal Trucks.

This was briefly discussed by Messrs. Bowen, Sanderson, Barr, Higgins and Gibbs. The point was made that except on refrigerator cars there is not much trouble from corrosion, and the best method of meeting that difficulty appears to be to take care of refrigerator car drip and discharge it clear of the trucks or the track. The session then adjourned.

Supervision of Standards.

Up to within about four or five years ago the association used to treat the standards which it had formerly adopted about as an ostrich treats its eggs. Once adopted that was the end of it, and, as a result, many of the standards for construction became practically obsolete with the changes in practice which are gradually made. In 1892, however, Mr. R. H. Soule, Superintendent of Motive Power of the Norfolk & Western, made a valuable report to the association, calling attention to this state of affairs, and as a result the standards of the association were overhauled. Some were amended, some abolished and a considerable class were put under the head of "recommended practice." A standing committee was also created, whose duty it is to report annually what changes are needed in the association's standards to keep them up to date. Mr. Soule is still the chairman of this committee and its report was the first presented at second session on Wednesday. The committee recommended minor changes in a dozen or more of the association's standards, practically all of which were agreed to by the association and will under the rules be submitted to a letter ballot for final approval. The most important result of its labors, however, was the appointment of committees to revise the standard specifications, tests, contract and guarantee for the purchase of cast-iron wheels, to report a new design of standard pedestal for passenger car service, and to revise the code of instructions for the use of air brakes and air train signals, in conjunction with a similar committee from the Master Mechanics' association.

Automatic Couplers.

The report of the committee which had been appointed to advise what changes are desirable in the size of shanks of M. C. B. couplers, and to recommend a standard yoke for the rear end attachment was called for, but it was announced that no report had been prepared. This is to be regretted, especially as respects the latter part of the duty laid upon the committee. More M. C. B. couplers are likely to be applied to cars in the next twelve months than in any previous twelve months, and if any changes are to be made in this standard, they should be

made without delay. The tail-bolt method of securing clean bars is now being generally condemned, and anything which the association can do to foster the use of the yoke method of attachment instead ought to be done.

Mounting Wheels.

Mr. J. N. Barr, the chairman of the committee on mounting wheels, presented its report. This submitted for the approval of the association three different gages; one a "standard reference gage," the second a check gage for use by car inspectors chiefly, and the third a special gage for use in mounting wheels to ensure placing them symmetrically on the axle. What the distinction was between the uses of the first and second gages the committee did not make very clear, but they were all passed to letter ballot.

Among the recommendations of the committee deserving especial notice are that second-hand wheels, at least, should always be mounted to the standard distance between backs of flanges and that wheels with flanges worn to 1⅛-in. or less thickness should not be remounted. Also that wheels fitted on the same axle should have flanges of the same thickness, the total variation never to exceed ⅛-in., and that axles should be centered between the centers of their journals prior to mounting.

The report on "Metal Underframing for Freight Cars" was then read. This was perhaps the most important report presented to the convention; but as it was accompanied by a large number of drawings, which we find it impossible to properly present, save on an inset sheet, we are obliged to postpone its publication to our next issue. The session then adjourned.

At the opening of the session on Thursday morning a letter was read from Mr. R. H. Wilbur, General Superintendent of the Lehigh Valley R. R., giving particulars furnished by Mr. C. A. Park, Carriage Superintendent of the London & Northwestern Ry., of the operation of the English Railway Clearing House, and the methods pursued in the interchange of cars on English railways.

Location of Air-Brake Cylinders on Freight Cars.

This committee, of which Mr. Jas. Macbeth was chairman, presented a report recommending that the air-brake cylinder be removed from its present position under the center of car to a position as near the side of the car as possible, the purpose being to facilitate the inspection and cleaning of the brake cylinder and the triple-valve. It also cautioned members to leave at least 12 ins. clear space between the head of the cylinder and the needle beams rung across the car to facilitate removing the head for cleaning. We quote further from the report as follows:

> The main air pipe should be located as near the outside line of side sill as possible. This will enable the men to readily reach and clean the drain cups in main air pipe, and will also place the pipe in a position on gondola cars, where the least possible injury will be caused by the dripping of water on pipe after having passed through bituminous coal that cars may be loaded with. The cut-out cock should be located under the car near the center, where it can be reached from either side, and be subject to the least interference by irresponsible parties, which already has developed. Air-brake branch pipe should be connected to top of drain cup in main pipe instead of bottom, in order to avoid, as far as possible, the tendency of dust and dirt to pass through strainer to triple valve. Release valve should be placed on top of reservoir, and handle extended to each side of car.

This is such a bold departure from the present general custom of placing the brake mechanism under the middle of the car that most of the members evidently regarded the proposal with a good deal of suspicion. The report was discussed at considerable length, both at this session and at a following one, but no action upon it was taken. The committee also reported a system of marking air-brake hose, which has been adopted quite extensively. Incidentally the report mentioned that about one-third of all the freight cars in service are now equipped with air brakes; and as it is the classes of cars that make the largest mileage that have been equipped, figures from inspection points show that about 55% of the freight equipment now interchanged has air brakes.

At this point Mr. F. D. Adams gave a brief sketch of the founding of the M. C. B. association, and described the meeting to organize the first association to control freight car interchange, which was held in the office of the Connecticut River R. R., in the early '60's. He introduced to the members Mr. John Mulligan, President of the Connecticut River R. R., who at that time was superintendent of the same company and who presided at that meeting. Mr. Mulligan briefly addressed the members and congratulated them on the association's prosperity.

Amendments to the Rules of Interchange.

For three years now the movement toward a radical revision of the Rules of Interchange to make the owners of cars responsible for repairs to them not due to fault on the part of the user has been gaining strength. Last year it came very close to success; and the general working of what is known as the Chicago interchange, which our readers will recall have already been in use for over two years between the roads centering at Chicago, has continued to be so satisfactory that this year everybody came to the convention either enthusiastically in favor of the new plan, or with his mind made up to give the new rules a fair trial. A special committee of 21 members had drafted a new code of rules, modeled on the old ones as far as possible, but designed to carry out the broad principle of making car owners responsible for repairs to their cars and thus abolish so far as possible that "old man of the sea" the "defect card," a piece of red tape that has been endured as a necessary evil for many years, but from which everyone is glad to be delivered. The draft made by this committee of 21 was revised and approved by the association's arbitration committee, and at the Thursday morning session of the convention was formally adopted by the association almost exactly as presented. It was gone over section by section in the meeting and only two minor changes were ordered in the entire code. The association is to be congratulated on this result, and great praise is due to a few of its members who have worked early and late to bring about this result. The value of the change to the railway companies and to shippers in expediting the movement of freight and insuring expenses in car inspection and car repair accounts promises to be very great.

Discussion of Topical Questions.

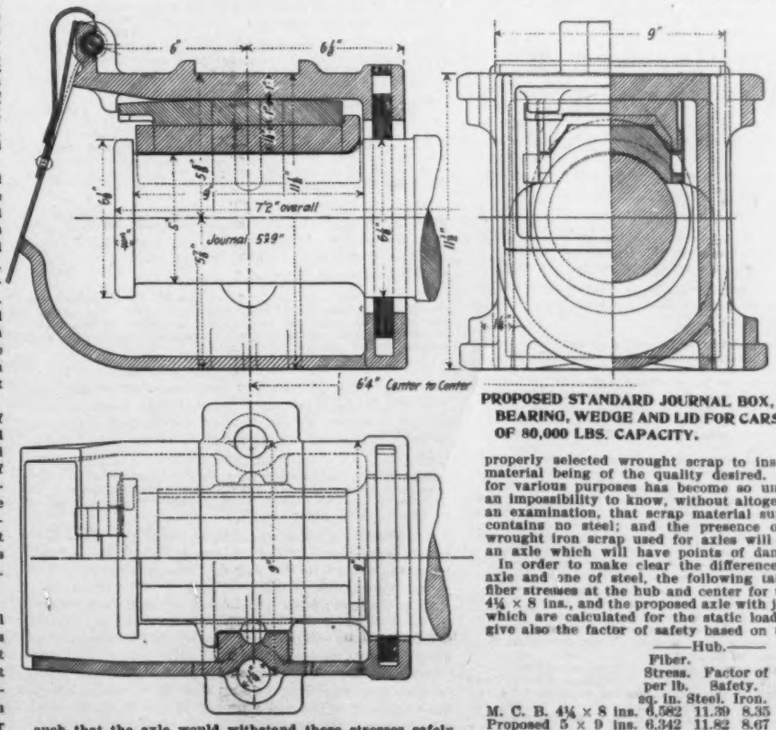
The Metric System.—This topic was discussed by Messrs. Higgins, Sanderson and Gibbs, all of whom expressed decided opposition to it. On motion the Executive Committee was instructed to prepare suitable resolutions to be forwarded to Congress expressing the sentiment of the association as being opposed to the compulsory introduction of the metric system in this country at any time.

(5.) Should not two iron buffer blocks be used on cars when M. C. B. couplers are applied?

This question was discussed at much length, and it was universally agreed that buffer blocks are essential, and that failure to use them invariably causes a large amount of breakage of M. C. B. drawbars. On motion of Mr. Rhodes it was adopted as the sense of the convention that wherever M. C. B. drawbars are used, buffer blocks should be applied at the same time. A motion by Mr. Soule was also carried that the practice of using buffer blocks with M. C. B. couplers be submitted to letter ballot as one of the standards of the association. The session then adjourned.

Axle, Journal-Box, Bearing and Wedge for Cars of 80,000-lbs. Capacity.

This was the first business taken up on Thursday afternoon and was by far the most extended of any of the reports submitted at the convention, containing some 30 pages. The committee did what has never been done before, so far as we are aware, in designing a standard axle for the association. It carefully computed the stresses in the axle due to the maximum load which might be expected to come upon it and then adopted proportions such that the axle would withstand these stresses safely during its life.



PROPOSED STANDARD JOURNAL BOX, BEARING, WEDGE AND LID FOR CARS OF 80,000 LBS. CAPACITY.

In computing the external forces, it became necessary to decide on the allowable fiber stress. The committee in deciding this took up Wohler's experiments on the effect of reversal of strains and finally reached the conclusion that a material will not be injured if only strained within a limit less than its natural elastic limit, which is considerably below the elastic limit as ordinarily considered. He also concluded that whether or not it be true that crystallization results from repeated alternations of stress, no such effect is likely to occur before the axle is worn out at the journals, provided the fiber stress is kept below the natural elastic limit. The effect of this feature was then discussed, and it was concluded that it need not be taken into consideration.

Finally, on examining the results of experience, it was found that among a large number of axles with a fiber stress of 28,000 lbs., a large number of breaks had occurred. On the other hand, another set of journals, with 23,000 lbs. and less showed practically no breakage; therefore it was concluded that a fiber stress of 22,000 lbs. might be assumed for that portion of the new axle between the wheels. For the fiber stress in the journals, it was decided to limit the fiber stress to 10,000 lbs. per sq. in. when the journal has reached its limit of wear.

The question of necessary area of journal for lubrication was then taken up and it was decided that 600 lbs. per sq. in. was a safe unit pressure for good lubrication. In computing the weight which may come upon the journals, it was found that for an 80,000-lb. car an axle should be designed for a static load of 31,000 lbs. Then it was found by Reuleaux's method that the axle in question should be 6¼ ins. diameter at the hub, and 5⅝ ins. at the centre, with journals 5 × 9 ins.

The committee then took up the matter of a specification for both steel and iron axles and prepared such specifications which were submitted with the report. The specifications for iron axles were prepared in deference to the opinions of those who still prefer iron axles, but the committee added the following pertinent comments:

> Concerning the employment of iron or steel, it may be reasonably assumed that for iron axles it is impossible, even with the best material, to obtain uniformity. A test made of one axle out of a lot, does not, therefore, represent the quality of the lot from which it is taken. For steel axles, the specifications submitted above will insure, within a reasonable probability, that the lot from which one is taken is fairly represented by the one axle tested. Furthermore, it is now almost impossible, or at least will be impossible within a short time, to obtain sufficient properly selected wrought scrap to insure axles of this material being of the quality desired. The use of steel for various purposes has become so universal that it is an impossibility to know, without altogether too elaborate an examination, that scrap material supposed to be iron contains no steel; and the presence of steel pieces in wrought iron scrap used for axles will certainly produce an axle which will have points of dangerous weakness.

In order to make clear the difference between an iron axle and one of steel, the following table will show the fiber stresses at the hub and center for the M. C. B. axle, 4¼ × 8 ins., and the proposed axle with journals, 5 × 9 ins., which are calculated for the static load only, and which give also the factor of safety based on ultimate strength:

	——Hub.——			——Center.——		
	Fiber. Stress. per lb. sq. in.	Factor of Safety. Steel.	Iron.	Fiber. Stress. per lb. sq. in.	Factor of Safety. Steel.	Iron.
M. C. B. 4¼ × 8 ins.	6,582	11.39	8.35	10,331	7.26	5.32
Proposed 5 × 9 ins.	6,342	11.82	8.67	10,011	7.49	5.49

In this table the factor of safety is based on steel of an ultimate strength of 75,000 lbs. per sq. in., and iron of an ultimate strength of 55,000 lbs. per sq. in. The table shows for the factors of safety at the centers, that if the strength of steel is 100 then the strength of iron is 73.3.

It must not be supposed that the factors of safety here given represent the actual margin of strength in the axles referred to. They are purely hypothetical factors of

safety based upon only the strains due to static loads, and the actual factors of safety where all strains are considered will be much smaller. The table merely indicates the relative values of iron and steel.

In both specifications a drop test is required in which the anvil is mounted on springs similar to that illustrated in Engineering News of May 14.

After completing its design for axles the committee prepared designs for a journal-box, wedge and bearing to be used with it, and presented with its report. The accompanying drawings show this construction. The axle was ordered submitted to letter ballot for adoption by the association.

Tests of Brake-Shoes.

For about four years the association has been engaged in elaborate and exhaustive tests of brake-shoes, one committee having charge of tests of the friction and wear of brake-shoes subjected to test on a special machine, and another committee testing brake-shoes in large numbers in actual service on different roads. The present report was a summary and final report of the work of these two committees. These tests are doubtless by far the most elaborate and extensive ever made upon the friction and wear between unlubricated surfaces, and any one engaged in the study of that topic would do well to obtain a complete set of the association's reports, in which these experiments are recorded in detail. The committee on laboratory tests in this year's report stated, among other things, that experiments with flanged shoes had shown that they had no advantage in holding power, except that the flange increases the area of surfaces in contact, thus reducing the unit pressure which increases the coefficient of friction. The same thing is true of shoes 17 ins. long instead of 13 ins., the length of the standard shoe. The practical lessons to be gained from the work of the two committees are summarized as follows:

For the prevailing conditions which surround the use of chilled cast-iron wheels in freight service, the shoes which would be found most economical and efficient would probably be wrought iron, Congdon, soft cast iron and hard cast iron in the order named. For use on chilled cast-iron wheels in passenger service, wrought iron, pressed steel, Meehan, soft cast iron and hard cast iron, in the order named.

For use on steel-tired wheels under the conditions which usually prevail in passenger service, it was difficult to name any one of the several brake-shoe metals as certain to produce good results, owing to the fact that very wide ranges of friction were developed and a very wide range of effect on the tire itself; the result being that cast iron is the only material which can be relied on to give uniformly satisfactory results, both as regards friction, the wear of the brake-shoes themselves, and the effect of the brake-shoes on the steel tire.

Passenger Car Ends and Platforms.

Mr. E. W. Grieves (B. & O.) presented this report, which included drawings of a proposed design for a passenger coupler, buffer platform and car end construction. In making this design it was found necessary to adopt several features which are claimed to be covered by patents, whose validity has been approved by the Eastern Railroad Association. As the association by its constitution can adopt nothing which is the subject of a valid patent, no action was taken upon the report.

Freight Car Doors.

This committee, of which Mr. F. H. Soule was chairman, also ran foul of the vexed question of patents. It contented itself with submitting drawings of various promising styles of car doors and the following schedule of the points of merit which should be found in an "ideal" freight car door:

1. The door should be so constructed as not to be liable to bind or give trouble in working on account of swelling or warping slightly.
2. The door should be hung at the top with no rail at the bottom which can be bent, and, from being bent, interfere with the free running of the door.
3. The door should be hung so as to move readily by a small amount of force when applied either at the bottom, middle or at the top.
4. The door should not move easily enough to roll back and forth by the alternate forward and backward jerks that the car gives in a freight train.
5. The door should be so arranged as to be weather and cinder proof at the top, bottom and both sides when closed.
6. The door should be so constructed that when it is locked and sealed it would be impossible, without breaking and mutilating the door, to pry open the back end or bottom of the door, so as to permit entrance of a hand or hook to pull out portions of the lading.
7. The door should be so constructed that if the lading presses against it and bulges it out from the inside when it is closed, it cannot be pressed away from the car so as to swing out and strike passing trains or other objects at the side of the tracks.
8. The door should be so constructed as to make it absolutely proof against unhanging, excepting where the stop, against which it rests when open, is removed and the door taken off in the regular way.
9. The door should be so constructed as to prevent its swinging out when in its closed position, even though all the bottom brackets are removed.
10. The door should be so constructed as to be proof against swinging out when in its closed position, in case one of the hangers should be broken or lost off.
11. The door should have such a style of locking arrangement that it cannot be removed or tampered with from the outside, without at once making the fact known to the seal record taker as soon as he sees the fastening.

Some of the members thought the committee should have prepared a design of door which woud fill all these requirements and yet not infringe on any existing patents. The committee replied that if they were able to perform so difficult a task they should have felt inclined to patent it themselves, to secure proper compensation for their ingenuity. The subject was finally continued and another report will be presented upon it next year.

Topical Discussions.

The list of topical discussions was hastily run over in the noon hour on Friday and some very important matters were touched upon.

(6.) Can some more economical method be practiced in connection with air-brake hose? It is claimed that damaged hose can often be spliced, and that punctured hose can be filled and patched in the same way that rubber hose for other purposes is repaired.

Mr. Rhodes said that on the C. B. & Q. he had applied the methods of bicycle tire repairing to the repair of injuries to air-brake hose, and had effected some surprising economies. In many cases hose fails because of punctures, or because of injury at the nipple and at trifling expense can be made to last its proper life. He showed samples of hose repaired in this way and was heartily applauded.

(7.) Tail-bolt fastenings for drawbars. Should not the practice of using them be condemned, and the yoke fastening be advocated in its place?

An emphatic "Yes" was given to this and a resolution was passed that it was the sense of the convention that the tail-bolt should be abolished in all future construction.

(8.) What is the general practice in turning new cars out of shop, in regard to height from center of drawbar to top of rail? Is it not a mistake to turn them out higher than 34½ ins., and is it generally understood that the center line of drawbar is not necessarily the same as center of the link opening in the knuckle?

In reply to the first question it was stated that cars should not leave the shops higher than the standard, though it is sometimes done. The company doing it, however, runs the risk of having its cars stopped on the road and lowered at its expense. The discussion showed that not only are many master car builders mounting cars by the position of the knuckle opening, but many seem to think that this is the thing to do, and are unaware that the centre line of the draw-bar shank is the point to which the height should be measured.

(9.) Solid lead-lined journal bearings vs. filled shell bearings on freight cars. Which is the best practice?

Several members discussed this question and it appeared to be generally agreed that on account of the liability of the filling melting out of a filled shell bearing, and throwing the entire weight on the shell, the solid brass, lead lined, was better to use. Mr. Barr, however, uses a shell which will run all right even if the filling melts out, and therefore has no trouble.

(10.) Under the rules of interchange, is a railway company warranted in the removal of a dirty Westinghouse triple from an air-brake car and applying a clean Boyden triple, or a New York triple?

Nobody offered to defend this practice, and probably no one has any real doubt as to its character.

(11.) Is it desirable to have greater uniformity in car construction? If so, are there other parts of freight cars that could be wisely standardized? What parts is it most desirable to standardize?

Mr. R. H. Soule suggested that the principal dimensions used in truck construction might be made standard, and suggested also steel center-plates, and steel under frames. Further draft-rigging standards and sections for truck arch-bars were also proposed.

(12.) Can the relation between the M. C. B. rules and the M. C. B. standards be made more close, and can not the M. C. B. rules be used as an incentive to more extensive introduction of the recognized standards and recommended practice?

Mr. A. M. Waitt suggested that the Rules of Interchange might be amended so that the repair of any part with the M. C. B. standard for that part would be permitted, no matter whether the part was M. C. B. originally or not. This would certainly foster the use of the standards.

(13.) Will a railway company be conforming to the law requiring power brakes on freight cars regardless of whether its power brakes meet the specifications adopted by the M. C. B. Association?

Mr. Rhodes, in answering this question, gave some personal reminiscences of the Burlington brake tests of 1886, when the shocks in the rear car became so severe that riding there became dangerous, and even the representatives of the brake being tested dared not stay there longer, so the tests were stopped. This shows what may result if brakes which do not meet the M. C. B. specifications are allowed to go into service.

On motion a resolution was adopted that the association be placed on record as holding that triple valves which have not been tested and approved by the M. C. B. committee should not be applied.

(14.) Is the present M. C. B. standard shape of wheel tread and flange the best that can be designed for service?

Mr. Barr presented blue prints of a standard wheel tread section adopted on the Chicago, Milwaukee & St. Paul six years ago, and which had been found to give excellent results.

Hand-Holds and Height of Drawbars.

This report summarized the work done by a committee of the association in formulating standards for securing the safety of trainmen in accordance with the railway safety appliance law. After some discussion and minor amendments it was voted to submit the report in letter ballot for adoption as a "recommended practice" of the association.

Uncoupling Arrangements for M. C. B. Couplers.

There has been serious and growing complaint of the needless diversity in the unlocking gear of M. C. B. couplers of different makes, and this committee was appointed "to consider whether a standard uncoupling device is practicable." The committee, through Mr. G. L. Potter, its chairman, reported that "it does not seem to be practicable to make a design of uncoupling lever that would be applicable to all the different couplers, or even to all those which are used in considerable numbers." It was urged in criticism of this report, however, that while this was true, it would be practicable to design an uncoupling gear which would be applicable to over 80% of the varieties of couplers on the market (and probably to 95% of those in actual use), and the committee was continued another year with instructions to report a standard unlocking gear which would be applicable to as large a number of couplers as possible. It will also take into consideration the amount of slack in uncoupling chains and other features of importance in connection with the knuckle locking and opening gear.

Stenciling of Cars.

This committee reported a code of rules for stenciling cars, in accordance with a request from the Car Inspectors' Association, and it was ordered submitted to letter ballot. The objects are to facilitate the work of car inspectors and car record takers. It is often difficult to read car numbers and initials at night where they are all high up on the side, so the new code requires them to be marked on the outer face of the outer floor timber. Also cars with eaves 12 ft. or more above the rail must have the width at eaves marked on side of car near the bottom. The style of coupler and attachments, brake beams, size of journal, and air brakes, if the car is equipped with them, are also to be lettered on cars to enable car inspectors to determine what equipment belongs to a car.

Concluding Business.

This completed the technical work of the convention. The committee on subjects for consideration at the next convention reported the following list:

1. Further consideration and suggestion of rules for loading logs, poles, bark, long iron, bridge material, etc.
2. Break-in-twos; causes and effect, and suggest a remedy.
3. Present a design for a passenger car pedestal and oil box, for 4½ × 8 in. journal.
4. Revise specifications and guarantee for cast-iron wheels, including a consideration of the form of wheel.
5. In conjunction with a committee from the Master Mechanics' Association, revise the Code of Rules pertaining to air brakes and signal instructions.
6. Follow up and report on improved buffers for freight cars.
7. Submit designs of side and end doors for box cars, including fixtures for adoption.
8. Recommend section of archbars and archbar bolts for cars of 60,000 pounds capacity, and submit design for archbars and archbar bolts for cars of 80,000 pounds capacity.
9. Consider the subject of trucks, springs, and what can be done in the way of standardizing them for cars of various capacity.
10. Advise what changes may be necessary in the standard size of M. C. B. automatic coupler shank, and recommend standard yoke or pocket strap for rear end attachments.

The report of the committee was accompanied with the following resolution, which was adopted: "Resolved, That the Master Car Painters' Association be requested to investigate the subject of protective paints for metal framing of car bodies and trucks."

It was voted that the association return next year to its former custom of meeting on Tuesday and holding but one session a day. The election of officers was next in order and the secretary cast the ballot for the names which had been reported by the Nominating Committee at a previous session, and the following were declared elected: President, S. A. Crone (N. Y. Cent.); Vice-Presidents, E. D. Bronner (Mich. Cent.); C. A. Schroyer (Chic. & Nw'n); J. T. Chamberlain (Bost. & Me.); Treasurer, G. W. Demarest (No'n Cent.); Members of the Executive Committee, G. W. Rhodes (C., B. & Q.); Pulaski Leeds (L. & N.), and M. M. Martin (Wabash).

After the usual resolution of thanks had been presented and adopted, the final adjournment was taken, closing one of the most successful conventions that the association has ever held.

The total number of persons drawn to Saratoga by the convention, including the families of the members and the representatives of railway supply companies, accompanied in many cases by members of their families, was probably from 1,200 to 1,500. The usual profuse entertainment and diversions for all those in attendance was provided by the Supply Men's Association, and on Saturday, through the courtesy of the Delaware & Hudson Canal Co., a party of several hundred were taken on a delightful excursion to Fourteen Mile Island in Lake George.